In Memoriam of Dr. Genady P. Cherepanov

1937 -2021

A Tribute to Dr. Cherepanov's Scientific Legacy

Genady P. Cherepanov, Honorary Life Member of the New York Academy of Sciences (elected 1976), was a distinguished mechanician whose primary contribution to science lies in the development and application of invariant (path-independent) integrals to problems of fracture mechanics, elasticity, fluid dynamics, and — late in his career — cosmology. His 2019 monograph, Invariant Integrals in Physics, represents the culmination of six decades of work. In it, he demonstrates that the law of energy conservation, expressed through invariant integrals, can serve as a unifying principle from which many classical and modern physical laws can be derived, corrected, or extended. He is best understood not as a revolutionary who overturned fundamental physics, but as a brilliant applied mathematician and mechanician who fearlessly challenged foundations — questioning established theories, confronting scientific orthodoxy, and correcting long-standing problems where correction was due.
Among his most significant achievements is the first complete mathematical theory of hydraulic fracturing (fracking) which allows engineers to predict the shape of fractured rock volume and gas output from first principles. This work has profound implications for the multi-billion-dollar oil and gas industry. He also solved the two-hundred-year-old problem of rolling friction, deriving analytical expressions for the rolling resistance coefficient for cylinders, balls, and tori on elastic foundations. Railroad and automotive engineers can now calculate rolling resistance rather than rely on empirical tables.

In contact mechanics, Cherepanov solved the Hertz-Muskhelishvili stick-slip problem, introducing a dimensionless brittleness number that separates brittle fracture from plastic flow. His work explains why stuck objects suddenly slip — a phenomenon relevant to brakes, tires, earthquake faults, and machining. He also modeled the catastrophic growth of pressurized cylindrical cracks, known as gryphon cracks, which caused the 2010 Gulf of Mexico oil spill and nuclear reactor failures at Chernobyl and Fukushima. These contributions provide quantitative tools for industrial disaster prevention.

He founded the field of nanofracture mechanics — originally named "Quantum Fracture Mechanics" (1990) and later renamed "Nanofracture Mechanics" (a name suggested by John Gilman). He developed the first complete, unified, discrete atomic theory of dislocation generation, crack growth, and cleavage decohesion, built from first principles using atomic force balances and dislocation theory. He introduced the brittleness number to determine whether a crystal behaves ductile or brittle. Unlike all prior models, his theory can handle the emission and stable settlement of multiple dislocations — a crucial capability for describing real material behavior. This work, supported by an NSF grant, bridged atomistic and continuum descriptions of fracture for the first time in a unified manner and established an entirely new branch of mechanics.

Cherepanov re-derived several classical laws — Archimedes' buoyancy principle, Newton's laws of motion, Coulomb's law of electric charges, and Einstein's $E=mc^2$ — from his invariant integral, demonstrating the unity of conservation principles. He also derived the shape of an optimal airfoil that maximizes flight speed before shock waves form, a design not yet widely adopted but mathematically complete. He developed the theory of fluidization of particulate media (with Gupalo and Galin), providing the first rigorous mathematical foundation for fluidized bed reactors used throughout the chemical and petroleum industries. He generalized Galileo's equistrength principle for arbitrary structures, predicting many equistrong configurations including turbine blades, rotating disks, and underground tunnels.

In explosion physics, he developed the theory of explosion effects in brittle materials — the counterpart to the Taylor–Grigorian theory for plastic materials — applying fracture mechanics to blast-induced cracking in rock, concrete, and glass. He applied catastrophe theory to fracture mechanics, proving that failure criteria for brittle materials are path-dependent and do not meet Drucker's postulate, establishing that brittle failure is inherently a catastrophic phenomenon. His 1997 monograph, Methods of Fracture Mechanics: Solid Matter Physics, integrated complex analysis, Mellin transforms, the Wiener-Hopf method, invariant integrals, catastrophe theory, and fractal geometry into a unified treatment of fracture phenomena, establishing nanofracture mechanics and fractal fracture mechanics as distinct subfields.

Beyond his scientific achievements, Cherepanov was a man of profound moral courage. During the glasnost era in the late Soviet Union, he published samizdat

works — underground, self-published texts circulated at great personal risk. He wrote openly against military expansion, KGB repression, and autocracy. He addressed an open letter to President Gorbachev, engaged with the legacy of Solzhenitsyn, and developed mathematical models of social justice and labor migration. These works reveal a man of science who would not be bounded by the laboratory — who brought the same rigorous approach to questions of human dignity as to fracture mechanics, and who put his own safety at risk to stand against authority.

In cosmology, Cherepanov developed the NEOC (Neoclassic Cosmology) model, rejecting general relativity in favor of a flat, Euclidean universe in which dark energy emerges naturally as a repulsive term proportional to distance, which he later interpreted as the centrifugal force of a slowly rotating universe. His galactic rotation formula correctly predicted the Milky Way's total mass, a result recently confirmed by Gaia DR3 data.

Cherepanov's corrected laws merit thoughtful consideration. Archimedes' principle with surface tension, the generalized Coulomb law for relativistic charges (CBC law), and the analytical rolling friction law belong in university physics and engineering handbooks. His re-derivations of Newton's laws and Einstein's equation as particular solutions are remarkably elegant and serve as a brilliant example of a creative approach to fundamental problems in physics. His foundational work in nanofracture mechanics, fluidization theory, and equistrong design deserves inclusion in materials science, chemical engineering, and structural optimization textbooks.

"He brought the rigor of fracture mechanics to everything — from a rolling wheel to the expanding universe, from atomic dislocations to exploding stars."

Across his long career, Dr. Cherepanov contributed to at least 17 major scientific fields and roughly 91 distinct subfields—from pure mathematics and fracture mechanics to geophysics, cosmology, political science, and mathematical sociology. By any measure, he deserved multiple major international awards: the Nobel Prize in Physics, the Timoshenko Medal, the Tribology Gold Medal, the Anthony F. Lucas Gold Medal. Yet history was not generous. Cold War-era publication isolation, bitter priority disputes (the J-integral, also denoted Γ-integral in Cherepanov's original work, and the HRR singularity), his own aversion to self-promotion, and his later unconventional positions (NEOC cosmology, WTC collapse analysis) kept him on the margins of official recognition. He received the Lenin Komsomol Prize in 1972 and the Fulbright Prize in 2000—but these honors, however genuine, remain a pale shadow of what his work truly merited.

Genady P. Cherepanov will be remembered as a creative and fearless scientist — one who made the corrections that physics needed, founded new fields, solved century-old problems, challenged dogma, and risked his freedom to speak truth to power.

What Dr. Cherepanov's peers say

Dr. John Hutchinson from Harvard University:

"I regard Dr. Cherepanov as one of the most original and productive solid mechanics researchers in the world. He has worked broadly with great insight in a number of areas. I am especially familiar with his many contributions to fracture mechanics, which are second to none. His book collects many of these together. It is an impressive volume, both in volume and content… It is not out of line to call him the "Russian Jim Rice". He has a proven record of brilliance and high productivity… Dr. Cherepanov's interests are really quite broad… he is a remarkable individual."

Sir Alan Cottrell of the University of Cambridge Awarded a Knighthood by Queen Elizabeth for His Achievements in Materials Science:

"He is an applied mathematician who concentrates on the mechanics of solids. A strength of his approach is that he works on realistic materials, containing cracks, dislocations, etc, rather than on idealized ones. This has made his researches most fruitful, since he is able to bring powerful techniques of applied mathematics to bear on problems of practical importance. He has made many pioneering and decisive contributions, especially in the field of fracture mechanics, and several of his original discoveries have later been 're-discovered' by later investigators, often with insufficient acknowledgement… This major figure in the mechanics of solids will receive the world recognition that he so well deserves."

Dr. James Rice from Harvard University:

"Dr. Cherepanov is one of the major world figures in the field of the mechanics of solids and, most especially, in the area of fracture theory. He has important contributions to the understanding of crack tip processes and fracture mechanisms, and also to the field of composite materials. He independently discovered the path-invariant crack tip integral which has played a major role in the development of nonlinear fracture theory in this last quarter century, and he provided new basic solutions for dynamic phenomena in fracture, for all manner of static crack problems, and for fractures along material interfaces… He is a highly creative thinker and turns out ideas at a remarkable rate... My respect for him and admiration for his scientific accomplishments are enormous…

Dr. Cherepanov is very interested in education and has been a prolific writer of books on various aspects of solid mechanics. His book "Mechanics of Brittle Fracture" (issued in English translation by McGraw Hill in 1979, as an update of the 1974 Russian original) is a widely recognized classics. He has also written books on elastic-plastic stress analysis and on the mechanics of composite materials. He is certainly able to teach courses in all aspects of mechanics and in much of materials and applied mathematics."

Dr. Fazil Erdogan from Lehigh University:

"Professor Cherepanov is a highly original and very profilic researcher. In both quality and volume , his contributions to Applied Mechanics have been simply phenomenal. In terms of breadth and originality of his work, he is among the very best of all scientists in Applied Mechanics, particularly in fracture mechanics. He has made fundamental contributions on nearly every aspect of fracture mechanics, including brittle fracture, equilibrium cracks, linear and nonlinear mixed boundary value problems, path-independent integrals, inelastic fracture, fracture of Earth's crust, dynamic fracture, environmental cracking, rock mechanics, theory of microdefects, fatigue and creep cracks propagation, composites and many other topics."

Biography of Dr. Genady P. Cherepanov

(**1937 – 2021**)

Early Life and Childhood

Genady Petrovich Cherepanov was born on January 8, 1937, in the village of Krutaya, Lyakhovsky District, Vladimir Region, into a peasant family — in the very same house where, seventeen years earlier, his mother, Alexandra Petrovna Cherepanova (maiden name Gorkina), had been born. His father, Pyotr Vasilyevich Cherepanov (1915–1942), was a captain in the Red Army and, in civilian life, a collective farm accountant. He was killed in action on November 29, 1942, near Velikiye Luki — known as the 'Little Stalingrad of the North' on the Eastern Front — while leading his battalion in an attack against a well-fortified German machine gunner who was guarding a strategic height.
The war years were marked by extreme hardship. In the late summer of 1942, young Genady and his mother rented a corner inside a typical single-room Russian log house. His mother worked long hours at a local collective farm, earning bread and a few potatoes. The bread ration was only 200 grams per person per day. To survive, Genady and some of his friends raided bird nests for eggs, gathered wild onions in the meadows by the Oka River, chewed on wheat and rye straw, collected mushrooms and berries, and fished with rods and nets. This was the harsh reality of rural life during wartime.

From the age of seven, Genady took on adult responsibilities. He carried an axe, gathered firewood from the forest, chopped it, and carried it home on his back or on sleds in winter. He also fetched water from the well. No one asked or forced him — he understood that if he did not complete these tasks, there would be no heat or water. These experiences forged in him a spirit of independence and self-reliance that would define his entire life.

Education and Early Academic Career

After graduation from high school in the small rural town of Melenki in May 1954, Genady took his father's officer's bag, in which only a towel, socks, a notebook, his medal, and school documents fit, as well as a loaf of bread and a few boiled eggs, and left his mother's house, which had been built by her brother four years earlier. His mother had spent all her savings on lumber for house construction. Genady headed to the railway station, jumped on a moving train, and arrived in Moscow without a ticket. He knew that living in Moscow on 10 rubles a month, which represented a third of his family's entire monthly income, would be next to impossible. He could not afford a train ticket, so he jumped onto a moving train and arrived in Moscow without one — saving every ruble for the uncertain months ahead. His mother, who had always dreamed of a more stable and honorable path for her son, had hoped he would become a priest. But Genady,

though uncertain of his own direction, felt an ever-growing pull toward mathematics..

While in Moscow, he visited the admissions office of the Physics and Technology faculty at Moscow State University on Mokhovaya Street. Medalists were accepted without exams, but the scholarship was small, only 29 rubles, making it difficult to survive on. As Genady walked through the courtyard, he noticed a poster for the Moscow Institute of Physics and Technology (MIPT). The scholarship there was 45–75 rubles, but medalists were required to take exams like everyone else. Genady spent the night sleeping on a bench in a park, and the next morning submitted his documents to MIPT. Despite being hungry and covered in sores from a month of living on 29 rubles, Genady made it to the top ten on the exams. Out of his group of 649, eleven were medalists, but only 200 out of approximately 10,000 applicants were accepted. Five of his group went on to become PhDs, while the rest became MSs.

At the MIPT dormitory, Genady encountered white bedding sheets for the first time and saw his first movie. His new comrades laughed at his lack of knowledge about things that were considered common knowledge — they found it hard to believe that he did not know such simple things. Notably, he was not a member of the Komsomol (the Soviet youth organization), the first such case in MIPT's history, and he had no intention of joining. His mother had always believed that members of the Communist Party and affiliated organizations were dishonest people, and from childhood she had instilled in him the importance of staying away from them — though he would later come to realize that even among Party members, good people could sometimes be found.

MIPT was then an elite institution, but Genady rarely attended lectures. He found them burdensome — he often did not understand the material as readily as others, and his questions sometimes seemed unusual to his peers and professors. Without comprehension, he could not simply take notes, so he stopped attending lectures from his first year and prepared for exams independently using textbooks. Fortunately, MIPT was the only college in the country at that time that allowed students to skip lectures. The lecturers, however, were not pleased and were especially "attentive" to him during exams. Despite this, he failed only one exam — Ovsyannikov's course on the theory of functions of a complex variable — which he retook and passed with an excellent mark. That subject would later become his great advantage, helping him solve many fundamental problems. He considered Professor Ovsyannikov his "godfather" in mathematics.

Scientific Breakthroughs and Academic Achievements

After graduating from MIPT in 1960, Cherepanov's life became a combination of outstanding scientific achievements and struggles for survival in the complex game of science and politics. In 1962, he defended his Candidate of Sciences dissertation at Moscow State University, and in 1964, at the age of 27, he defended his Doctor of Sciences dissertation at the Institute of Mechanics of the

Academy of Sciences of the USSR — making him the youngest Doctor of Sciences in Mathematics and Physics in the USSR at that time. Both dissertations were devoted to exact analytical solutions of mechanics problems with unknown boundaries, particularly non-one-dimensional elastoplastic problems. His dissertation opponents were L.A. Galin, F.D. Gakhov, D.I. Sherman, and R.V. Zvolinsky.

From 1963 to 1969, he worked as a Senior Research Fellow at the Institute of Mechanics and later at the Institute of Problems of Mechanics of the Academy of Sciences of the USSR. He then served as Professor of Mathematics at the Moscow Mining Institute (1969–1978), Senior Research Fellow at the Moscow Research Institute of Drilling Technology (1978–1987), and Head of the Laboratory of Mathematical Modeling at the Institute of Oceanology of the Academy of Sciences of the USSR in Vladivostok (1987–1990).

For five years, from 1967 to 1972, at the initiative of Yu.N. Rabotnov, he lectured on fracture mechanics at the Department of Elasticity Theory at Moscow State University — the first course on this new discipline in the Soviet Union. Regular attendees included V.Z. Parton, E.M. Morozov, V.D. Kuliev, and other future Doctors of Sciences and professors who would become renowned scientists.

In 1967, Cherepanov derived the invariant (path-independent) integral for fracture mechanics, dynamics, and statics of continuous media, specifically for solid elastic-plastic materials. In 1968, Rice proved its invariance for the statics of nonlinearly elastic materials. The corresponding integrals of Eshelby and Rice are special cases of the Cherepanov integral. Using his integral, he also found a self-similarity index at the crack tip. Later, these results became known as the HRR approach (Hutchinson-Rice-Rosengren method), as they published their solutions a year later, confirming all his results but without referencing his article — a priority dispute that would follow him throughout his career.

In the autumn of 1966, he began working on a book on fracture mechanics, which he completed in 1969. In the autumn of that year, he brought the finished manuscript to Academician L.I. Sedov at the Mechanics Institute of Moscow State University, announcing its completion. However, Sedov, who oversaw mechanics at the Nauka publishing house, decided to "dilute Cherepanov" (in his own words) and suggested that Parton and Kachanov write on the same subject. When they submitted their books, he published them simultaneously with Cherepanov's book. The book, Mechanics of Brittle Fracture, was finally published in 1974. In 1979, McGraw Hill published its English translation in the United States, establishing Cherepanov's status as a leading author in solid mechanics.

The Moscow Discussion and Scientific Politics

In January 1967, Cherepanov wrote a critical note stating that the theory of crack propagation in brittle materials, which G.I. Barenblatt claimed to have created, had already been developed by Griffith and Irwin. Furthermore, the "Barenblatt module" was nothing more than the fracture toughness introduced by Irwin

earlier. The note accused Barenblatt of intentional plagiarism, as he was well aware of the works of Griffith and Irwin. This note sparked the "Moscow Discussion" — a public confrontation that would have lasting consequences for Soviet science.

Another factor that provoked Barenblatt and his supporters was Cherepanov's major article published in May 1967, in which he proposed a universal theory of fracture applicable to any material — not just fragile materials like the Griffith-Irwin theory and Barenblatt's hypothesis. Barenblatt and his supporters needed to divert the scientific community's attention away from this seminal work in order to promote Barenblatt's election to the Academy of Sciences. Cherepanov found himself at the very center of a political battle for scientific power.

Reflecting on this period, Cherepanov wrote: "Personally, I do not regret participating in the Moscow Discussion, even though it caused me the most pain. A potential bureaucrat was prevented from being born, and an artist was given the opportunity to flourish. Millions of students around the world now study my ideas and methods. If I had withdrawn my critical note and refused to publish the article with the derivation of the invariant integral, as Barenblatt and Ishlinsky demanded, there would not have been a Moscow Discussion. In this case, the compliant Cherepanov would likely have been quickly elected to the Academy of Sciences and Barenblatt would have likely become its president, as planned by the powerful group of Zeldovich. The Academy of Sciences would have been even quieter and less noteworthy than it is today. I am guilty of disrupting this rosy future. Real history is written with tears and blood."

Struggles with the Soviet System

From 1974 to 1988, Cherepanov made several attempts to win election to the Soviet Academy of Sciences. His powerful and well-connected opponents used various means — including, according to his memoirs, KGB resources — to prevent his successful election.

Around 1975, a vehicle with diplomatic license plates attempted to crash directly into the small Fiat carrying Cherepanov and his wife Elena Odintsova — an actress from the prestigious Moscow Academic Art Theatre and a Soviet movie star at the time. Miraculously, they sustained only minor injuries because a random cab driver suddenly cut into their lane behind their car just before the assassin's vehicle approached at high speed. The cab was hit very hard but shielded Cherepanov's vehicle from a deadly impact. The taxi driver was found dead when the ambulance arrived. An investigation was launched but never found the perpetrator, and the murder case was abruptly closed.

In the spring of 1978, Dr. Cherepanov’s struggle for human rights reached its culmination. Cherepanov wrote an open letter to Brezhnev demanding personal freedom to travel abroad and criticizing the authoritarian regime.
In 1981, Genady Cherepanov was arrested by the KGB in Latvia during a scientific conference and brought for interrogation to Moscow, inside the notorious Lubyanka headquarters. The KGB officers accused him of the murder

of famous spacecraft designer and his friend Igor Berezjnoy, whose car had recently been blown up by a plastic bomb near the Institute of Mining Technology. The officers insisted that Cherepanov was an American spy assigned by the CIA to bring down Soviet science. Fortunately, Yuri Andropov, who was the chief of the KGB at the time, recognized that the accusations were fabricated from rumors and secret reports emanating from KGB informants and those who held a grudge against Cherepanov.

Reflecting on those days, Cherepanov wrote: "In those days, a passion for honest science could have ended tragically. Academics were afraid of Barenblatt, who had friends in high places, both in the Central Committee and in the KGB. He was able to travel abroad freely at a time when no one else was allowed to leave. Ishlinsky and Barenblatt were representatives of a new generation of scientist-politicians, for whom the ends justified the means. They were highly educated and well-informed in scientific matters, and they used their outstanding political abilities to gain power and defeat dissenters, even to the point of eliminating them physically."

International Recognition and Move to the United States

In 1976, Genady Cherepanov became the only scientist from the entire Soviet Union elected as an Honorary Life Member of the New York Academy of Sciences — one of the most prestigious academies in the world, which at that time had only about 100 members, almost all of whom were Nobel Prize winners.

In the late 1980s, Cherepanov wrote a paper entitled "The Mathematical Model of Totalitarian Autocratic Societies," in which he predicted the fall of the Soviet Union. He also had contact with world-renowned human rights activist Andrei Sakharov and participated in the Christian Democratic movement in Russia. Alexander Ogorodnikov, the head of the Christian Democratic Party, was once a guest in his home. Despite the freedoms promised by Gorbachev's perestroika, the pressure from the KGB apparatus continued, and he had no choice but to leave his homeland permanently.

In 1990, Cherepanov arrived in the United States and began working at Harvard University, where he had been invited as a Distinguished Research Associate in Solid Mechanics (1990–1991). He was invited by the famous American scientist Jim Rice. They had met twice in Moscow before and had corresponded. Rice had been studying the Russian language in order to read Cherepanov's original articles, which were published in Russian journals in the 1960s — journals that were delivered by airmail to Harvard's library just days after publication.

Cherepanov's poverty upon arrival was immediately apparent from his worn suit and worn-out shoes. He did not even have enough money for a ticket to Boston; the university purchased the ticket for him. Rice met him at the airport and took him to an apartment in Arlington belonging to an elderly retired secretary named Dot, who rented rooms to Harvard students and guests.

At Harvard, Cherepanov crossed paths once again with Barenblatt, who had flown immediately from Moscow to Boston upon learning of Cherepanov's presence. According to Cherepanov's account, Barenblatt persistently called Budiansky, trying to secure an invitation to Harvard. As Budiansky described it, Barenblatt was "like a jealous child," calling every night and talking for hours.

Later Career and Final Years

In the fall of 1991, Cherepanov accepted an offer from Florida International University and moved to Miami with his new wife Larisa and two children. He held the position of Professor of Mechanical Engineering at FIU from 1991 to 1998, where he lectured on advanced engineering and applied mathematics for PhD students. He sometimes asked willing students to conduct the lectures themselves — some of those who volunteered later became PhDs or professors themselves.

In the summers of 1997 and 1998, he worked as a Distinguished Summer Faculty Fellow at the Naval Research Laboratory in Washington, D.C., and at the Naval Air Warfare Center in New Jersey.

Cherepanov's children recall how their father would take them to the ocean, jumping in and swimming toward the horizon regardless of weather conditions or shark warnings, often returning after an agonizingly long hour. He would take them to the fitness center and lift weights like a young man, encouraging his children and impressing gym visitors.

Besides his love for sports, Cherepanov was an accomplished chess player. One day in 1990, after his work at Harvard, he played a chess master in Harvard Square, across from Au Bon Pain — a famous gathering place for chess players at the time. Cherepanov won the game, and the master, furious, slammed the chessboard against the table. He also played a chess master on a New Jersey beach in the summer of 1998, after rescuing the young man from drowning. Though Cherepanov did not win that game, he offered strong resistance, keeping the master on edge.

It is worth mentioning that Genady Cherepanov saved lives on two occasions:

First rescue (summer of 1969): While picnicking by the Kura River in Azerbaijan with a group of friends, Cherepanov rescued his Kurdish friend Nabi from drowning. Nabi had been playing in the river with children when the strong current swept him away. One of the children yelled, "Help!" Everyone froze in fear except Genady Cherepanov, who immediately jumped into the water and dragged Nabi to safety. It turned out that Nabi could not swim and had only wanted to cool off. At the time, Nabi served as an Assistant Attorney General in Kirovobad City (now Ganja), Republic of Azerbaijan.

Second rescue (summer of 1998): While working at the Naval Air Warfare Center in New Jersey, Genady Cherepanov was relaxing on the beach when he met an elderly man and his son — Jewish immigrants from the Soviet Union who spoke Russian. The son was an accomplished chess master who had recently received

a significant award. After their introduction, the young man went into the water and nearly drowned in an incoming wave. Cherepanov pulled him onto the sand and cleared the water from his lungs. After regaining consciousness, the grateful young man accepted Cherepanov's offer to play several games of chess.Genady Cherepanov also wrote poetry in both English and Russian — his creative mind never rested. His last scientific work, "Projectile Impact onto a Membrane," was published in Prikladnaya Mekhanika i Tekhnicheskaya Fizika, Vol. 62, Issue 5, 2021. This work has potential applications in the design of ballistic armor and spacecraft shielding.

Legacy and Passing

Genady Petrovich Cherepanov passed away at the age of 84 on September 1, 2021, in Miami, Florida.

Throughout his long career, Cherepanov contributed to at least 17 major scientific fields and 91 distinct subfields — from pure mathematics and fracture mechanics to geophysics, cosmology, political science, and mathematical sociology. He founded the field of nanofracture mechanics, solved the 200-year-old problem of rolling friction, developed the complete theory of hydraulic fracturing, resolved the Hertz-Muskhelishvili stick-slip problem, and introduced the invariant integral that would become foundational to modern fracture analysis.

He was a scientist who would not allow the exact sciences to become the boundary of his thought — and who applied the same rigorous approach to questions of human dignity as he did to fracture mechanics. He put his freedom at stake to speak truth to power, and he never stopped seeking answers to the most fundamental questions.

Note on Scientific Priority Disputes

This biography acknowledges, with appropriate neutrality, that certain priority disputes exist regarding the invariant integral (J-integral, also denoted Γ-integral in Cherepanov's original work) and the HRR singularity. These are matters of historical record and are presented without judgment, in accordance with the website's purpose of preserving a good memory of a great scientist and freedom-loving human being.

Sources

This biography is compiled from Genady Cherepanov's own memoir records, his published works, and historical records of his academic career and personal life.

Awards and Honors

Honorary memberships and affilations

* 1976 Honorary Life Member, New York Academy of Sciences — one of only 100 members ever to receive this distinction, elected alongside Linus Pauling and George Polya. The list of Honorary Life Members includes such outstanding scientists as C. Darwin, D. Mendeleev,
J. Maxwell, J. Gibbs, A. Einstein, N. Bohr, W. Heisenberg, A. Sakharov, P. Kapitsa, L. Pauling, George Polya, and others.
* Member, Russian National Committee on Theoretical and Applied Mechanics
* 1989 Honorary Fellow, International Congress on Fracture
* 1972 Board of Editors, Journal of Engineering Fracture Mechanics
* 1973 Member of Advisory Board, Journal of Applied Mathematics and Mechanics
* 1997 Board of Editors, International Applied Mechanics

Awards and grants

* Lenin Komsomol Prize 1970 (State Award)
* Fulbright Prize (1999–2000)
* NSF Grant # MSS 9224936 for "Mechanics of Quantum Fracture" (1992–93), $33,200.
* NASA Grant # 59204 for "Theory of the Motion of Meteor Particles in Solid Materials" (1992–95), $311,551. Two investigators.
* AFOSR Grant # 59107 for "Residual and Thermal Stresses in Thin Films and Interconnects" (1994–96), $43,973.
* U.S. ARO Strategic Defense Command Grant for "Structural Improvement of the Ground-Based Radar Systems Using Advanced Materials" (1994–97), $1,441,411. Five investigators.
These grants supported research that formed the basis of the 1997 monograph, Methods of Fracture Mechanics: Solid Matter Physics, and his other foundational works.

Publications and teaching activities

Dr. Cherepanov has authored at least seventeen books and more than 300 peer-refereed research papers published in 18 Russian and 12 American journals. His most comprehensive work, Invariant Integrals in Physics (Springer, 2019), represents the culmination of his scientific career and unified his discoveries across multiple fields.
Under the supervision of Dr. Cherepanov, 21 postgraduates have received Ph.D.'s, and 6 postdoctoral Sc.D.'s. At FIU, Dr. Cherepanov delivered 16 different courses on mechanics, materials, engineering, and applied mathematics

for graduate and undergraduate students. Approximately 130 BSs, 150 MSs, and 4 Ph.Ds have been educated on these courses.
In more detail, his biography has in recent years been elucidated in the following reference books:
* Marquis Who's Who in the World, 11th and other Editions
* Marquis Who's Who in America, 47th Edition
* Marquis Who's Who in Science and Engineering, 1st and other Editions
* Marquis Who's Who in the East, several Editions
* Marquis Who's Who in the South and Southwest, several Editions
* Men of Achievement, 16th Edition. International Biographical Center, Cambridge, U.K.
* Men and Women of Distinction. International Biographical Centre, Cambridge, U.K.
* International Man of the Year 1992/93. International Biographical Centre, Cambridge, U.K.
* American Men & Women of Science. A Reed Reference Publishing Co.
* The International Directory of Distinguished Leadership, Fifth Edition. American Biographical Institute
* Five Hundred Leaders of Influence. American Biographical Institute
* 2000 Outstanding Scientists of the 20th Century. International Biographical Centre, Cambridge, U.K. and other Editions.

Professional honors during his work at FIU

* Southwest Mechanics Lecture Series at Southwest Research Institute, Rice University, University of Houston, Texas A&M University, and Tulane University (October 1991)
* Honor Lecture at the 2nd Congress on Metallurgy in Mexico City (November 1992)
* Invited Paper at the 1993 ASME Winter Annual Meeting in New Orleans (November 1993)
* Honor Lecture Series at the University of Durban in South Africa (June 1994)
* Invited Paper at the 12th U.S. Congress of Applied Mechanics in Seattle (July 1994)
* Invited Paper at the IUTAM Symposium on Scale Effects in Turin, Italy (October 1994)
* Invited Papers at the World Congress on Fracture (1993, Lviv, Ukraine; 1997, Sydney, Australia)
* Honor Lecture at the European Congress on Fracture in Paris, France (September 1996, not delivered)
* and others.

Citation index:
More than 2,000 citations in English scientific literature alone.

Scientific Contributions

{I} The Invariant (Path-Independent) Integral (1967)

In 1967, Cherepanov introduced the invariant (path-independent) integral — a groundbreaking concept that quantifies the strength and driving force behind crack tip singularities. Unlike earlier formulations, his approach applies universally to both elastic and inelastic materials, and covers static as well as dynamic problems.

While Eshelby had previously developed a related integral for static elasticity in the context of point defects, and Rice later independently derived a version for static nonlinear elastic materials, Cherepanov's 1967 formulation was both earlier and more general. His derivation, based on the divergence theorem and the energy-momentum tensor, established that the integral remains path-independent provided no other singularities are enclosed. This gave him priority over Rice's J-integral (1968) and extended the applicability to dynamic and inelastic regimes.

The impact of this discovery has been far-reaching. The integral has been employed in contexts ranging from atomic-scale decohesion to large-scale geophysical phenomena, including landslides and earthquake ruptures (developed further in joint works with Bykovtsev during the 1970s and 1980s). It also sparked extensive research into new conservation laws and invariant integrals across various physical disciplines, as reflected in Cherepanov's publications from 1978 through 1989.

Mathematical Formulation of the Invariant Integral

The Invariant Γ-Integral

The cornerstone of Dr. Cherepanov's approach is his invariant (path-independent) integral. In its elegant form, as favored by Cherepanov, the integral is written as:

$$\Gamma = \int \left[n_1(W+K) - \sigma_{ij} n_j \partial u_{i,1} \right] ds$$

Where:

- Γ: The invariant integral, representing the energy release rate.
- n_1: The component of the outward unit normal vector in the direction of crack propagation.

- W: The strain energy density (the elastic energy stored per unit volume).
- K: The kinetic energy density.
- σ_{ij}: The stress tensor components.
- n_j: The components of the outward unit normal vector.
- $\partial u_{i,1}$: The derivative of the displacement component u_i with respect to the crack direction x_1. This is equivalent to the displacement gradient in the direction of crack propagation. The comma notation denotes partial differentiation, standard in continuum mechanics($u_{i,1} = \partial u_i/\partial x_1$).
- ds: An infinitesimal element of the contour.

This integral has three key properties:

Property	Description
Path-Independence	The integral has the same value for any contour around a crack tip
Energy Release Rate	Represents the energy available for crack propagation
Unified Framework	Applies to elastic, plastic, viscoelastic, and dynamic fracture

Applications of the Invariant Integral

The invariant integral has found applications across multiple fields:

1. **Fracture Mechanics**: The integral provides a unified driving force for crack growth in any material, from atomic decohesion to large-scale earthquake ruptures.
2. **Geophysics**: The integral has been applied to fault mechanics, landslide analysis, and earthquake prediction.
3. **Materials Science**: The integral connects macroscopic fracture energy to fundamental material properties.
4. **Cosmology**: Cherepanov extended the invariant integral to the cosmic-gravitational field, providing a foundation for his NEOC cosmology.

Impact: Transformed fracture mechanics by providing a rigorous, unified driving force for crack growth in any material.

Prize Worthiness: Timoshenko Medal (ASME), William Prager Medal (Society of Engineering Science).

Recognition Received: Widely recognized in fracture mechanics, but priority over J-integral often overlooked.

Recognition Deserved: Clear historical recognition as the discoverer of the general path-independent integral for fracture.

Related Works: "Crack propagation in continuous media" (1967); "Invariant Γ-integrals and some of their applications" (1977); "Invariant Γ-integrals" (1981).

{II} Introduced nanofracture mechanics

Introduced nanofracture mechanics as the general, unified theory of dislocation emission, crack growth and cleavage decohesion in terms of fundamental physical constants in nanoscale. The approach was published in J. Applied Physics, Soviet Applied Mechanics and Applied Mechanics Reviews from 1986 to 1995, and supported by NSF grant. (Original name for this approach was "quantum fracture mechanics", the name "nanofracture mechanics" was suggested by Gilman). A parallel work of Rice and Thomson in this area includes only nucleation of one dislocation and cleavage decohesion. He introduced the brittleness number $\boldsymbol{\eta = k_I/k_{IC}}$ to determine whether a crystal behaves ductile ($\boldsymbol{\eta < 1}$) or brittle ($\boldsymbol{\eta > 1}$). Unlike the Rice-Thomson model, his theory can handle the emission and stable settlement of multiple dislocations — a crucial capability for describing real material behavior. He is the founder of nanofracture mechanics as a distinct discipline.
Impact: Bridged atomistic and continuum descriptions of fracture for the first time in a unified manner.
Prize worthiness: Nobel Prize in Physics or Chemistry, Kyoto Prize (Materials Science), Von Hippel Award (Materials Research Society).
Recognition received: NSF grant; limited broader acknowledgment; his status as founder is not widely recognized.
Recognition deserved: Named lecture or award in his honor; inclusion in every textbook on nanomechanics and fracture physics.
Related works: "On the foundation of fracture mechanics: fatigue and creep cracks in quantum fracture mechanics" (1990); "The start of growth of micro-cracks and dislocations" (1988); "Nanofracture mechanics approach to dislocation generation and fracturing" (1994); Methods of Fracture Mechanics: Solid Matter Physics (1997).

{III} Solved some particular cases of long-standing Riemann and Riemann-Hilbert problems for several functions

Solved some particular cases of long-standing Riemann and Riemann-Hilbert problems for several functions (both linear and nonlinear) during 1961-65 under the influence of Gakhov's work in the area. He developed a new method using functional equations and analytic continuation to reduce multifunction and free-boundary problems to forms solvable by known techniques. This method applies to unknown boundaries in elasticity and plasticity, including problems where the contact area or crack path is not known beforehand.
Impact: Provided the mathematical foundation for solving mixed boundary value problems in continuum mechanics where the boundary itself is part of the solution.
Prize worthiness: Gakhov Prize (if existed), major prize in applied mathematics.
Recognition received: Moderate within Soviet mechanics; limited internationally.
Recognition deserved: Broader acknowledgment as a fundamental advance in complex analysis applied to physics.
Related works: "A non-linear problem in the theory of analytical functions" (1962); "The Riemann–Hilbert problem for cuts along a straight line or circumference" (1964); "Boundary value problems with analytical coefficients" (1965); "A method of solving elastic-plastic problems" (1963).

{IV} Solved several difficult mathematical problems of nonlinear mechanics with unknown boundaries

During 1961-1968, solved several difficult mathematical problems of nonlinear mechanics with unknown boundaries (in plasticity, elasticity, local buckling and hydrodynamics) using complex variables. To the end, developed more capable methods as compared to those advanced earlier by Kolosov, Muskhelishvili, Sherman, Sokolovsky, Galin, Keldysh and Sedov in the area. His method of functional equations allowed exact solutions for problems where the boundary itself changes during deformation, such as contact areas, crack paths, and free surfaces in fluid flow.
Impact: Advanced the mathematical toolkit for solving free-boundary problems in continuum mechanics.
Prize worthiness: Major prize in applied mathematics and mechanics.
Recognition received: Moderate within Soviet mechanics.
Recognition deserved: Broader recognition in the history of continuum mechanics.
Related works: "Some problems concerning the unknown body boundaries in the theory of elasticity and plasticity" (1965); "A method of solving elastic-plastic problems" (1963); various papers from 1962–1968.

{V} Generalized Griffith's concept of fracture for arbitrary solids and continua

Generalized Griffith's concept of fracture for arbitrary solids and continua (in 1967) later co-offered by Landis and Begley for crack initiation (in 1972). In the 80s, this concept was applied and developed by Atluri, Nishioka and many other investigators in numerical and physical experiments as applied to static and dynamic cracks in plastic materials. Cherepanov expressed this generalization through his Γ-integral, which automatically accounts for all dissipative processes near the crack tip (plasticity, viscoelasticity, etc.),

not just surface energy. This established that the work required to propagate a crack equals the total energy dissipation per unit area, regardless of mechanism.
Impact: Extended fracture mechanics from brittle materials to all structural materials.
Prize worthiness: Foundational contribution to fracture mechanics; Nadai Medal (ASME).
Recognition received: Modest outside specialist circles.
Recognition deserved: Inclusion in standard histories of fracture mechanics alongside Griffith and Irwin.**Related works**: "Crack propagation in continuous media" (1967); Mechanics of Brittle Fracture (1978).

{VI} Pioneered the so-called HRR approach in fracture mechanics of power-law hardening materials

Pioneered the so-called HRR approach in fracture mechanics of power-law hardening materials (1967) later co-discovered by Hutchinson, Rice and Rosengren. Cherepanov showed that stresses and strains near a crack tip in a nonlinear power-law material exhibit a singularity of the form $\mathbf{r^{-1/(n+1)}}$ where n is the strain hardening exponent. Cherepanov used the invariant integral to determine the amplitude of the singular field. This was his discovery, published in 1967, before the HRR papers of 1968–1970.
Impact: Founded elastic-plastic fracture mechanics, enabling prediction of ductile crack initiation.
Prize worthiness: Fracture mechanics award, plus correction of historical record.
Recognition received: Minimal; the approach is universally attributed to HRR.
Recognition deserved: Explicit acknowledgment of priority in historical accounts.
Related works: "Crack propagation in continuous media" (1967).

{VII} Discovered super-penetration effect of thin wing-shaped penetrators in solids at the Rayleigh speed

Discovered super-penetration effect of thin wing-shaped penetrators in solids at the Rayleigh speed. Publications in J. Applied Mechanics, Engineering Fracture Mechanics, Mechanics of Materials, and other journals (1994-95) supported by NASA grant. Thin wing-shaped penetrators can penetrate solids at speeds approaching the Rayleigh wave speed, achieving greater depth than conventional shapes. This work identified a new regime of high-speed penetration.
Impact: Identified a new regime of high-speed penetration with applications to space debris shielding and armor design.
Prize worthiness: Major contribution to impact mechanics; Hypervelocity Impact Society Award.
Recognition received: NASA-funded; known in hypervelocity impact community.
Recognition deserved: Broader acknowledgment in impact mechanics.
Related works: Publications in Journal of Applied Mechanics, Engineering Fracture Mechanics, Mechanics of Materials (1994–1995).

{VIII} Discovered the interaction law of relativistic charges (a generalized Coulomb's law)

Discovered the interaction law of relativistic charges (a generalized Coulomb's law) and introduced the model for unusual fracturing effect of high-power relativistic electron beams (with Borzykh, in J. Applied Physics, 1994). The generalized Coulomb law (CBC law) for moving charges is $\mathbf{F = (q_1q_2/\varepsilon R^2) \bullet (V^2/a^2 - 1)/(1 - V^2/c^2)}$). For subluminal charges (**V < a**) it reduces to the classic Coulomb law of attraction for opposite charges and repulsion for like charges. For superluminal charges (**a < V < c**), the force becomes attractive for like charges, causing electrons to coalesce into dense clusters that can cut through solids. This explained the unusual fracturing effect of high-power relativistic electron beams.
Impact: Demonstrated unity of conservation principles across classical and relativistic physics; provided theoretical foundation for relativistic electron beam weapons.
Prize worthiness: Theoretical physics award for unification; potential military science recognition.
Recognition received: Minimal; work too recent and non-mainstream.
Recognition deserved: Discussion in histories of physics; inclusion in advanced textbooks.
Related works: "Generalized Coulomb's law (the CBC law)" with Borzykh in J. Applied Physics (1994); Chapter 1 of Invariant Integrals in Physics (2019).

{IX} Developed mathematical description of stress accumulation and transfer around faults in the Earth's crust

Developed mathematical description of stress accumulation and transfer around faults in the Earth's crust (Physics of Earth, 1985; and the book of 1987). Cherepanov modeled how stresses build up around faults, how they are transferred to adjacent rock, and how this relates to earthquake triggering using fracture mechanics principles and the invariant integral.
Impact: Bridged fracture mechanics and geophysics; provided quantitative tools for understanding fault behavior and earthquake prediction.
Prize worthiness: Major contribution to geophysics and earthquake mechanics; Reid Medal (Seismological Society of America).
Recognition received: Known in geophysics literature; cited in some earthquake studies.
Recognition deserved: Broader acknowledgment in geophysics textbooks.
Related works: "Physics of Earth" (1985); Rock Fracture Mechanics in Drilling (1987).

{X} Discovered, with Galin, self-maintained failure waves

Discovered, with Galin, self-maintained failure waves (1967) later re-discovered by Bless, and many others in USA (1988-1995). The concept of structural bond energy

release introduced in this work stimulated the development of new energetic materials that have found many military and civil applications. These waves of structural degradation propagate through brittle materials under sustained compressive load, self-sustaining because the energy released by the failure process drives further propagation. Cherepanov provided updated mathematical models for fracture wave propagation including effects of material heterogeneity and rate-dependent properties in his 2010 paper "On self-sustaining fracture waves."
Impact: Introduced the concept of structural bond energy release as a driving mechanism for failure waves.
Prize worthiness: Major award in materials science or shock physics.
Recognition received: The concept is known but priority is often overlooked in Western literature.
Recognition deserved: Clear historical acknowledgment as the discoverer of self-maintained failure waves.
Related works: "Self-maintained failure waves" (1967, with Galin); "On self-sustaining fracture waves" (2010).

{XI} Introduced 2D theory of thermal stresses in thin films and bonding layers as applied to high-speed microelectronics

Introduced 2D theory of thermal stresses in thin films and bonding layers as applied to high-speed microelectronics (J. Applied Physics, 1994-95). The research is supported by AFOSR grant. This theory provides quantitative tools for predicting and preventing thermal stress failure in microelectronic devices, including delamination and cracking of thin film layers.
Impact: Provided quantitative tools for predicting and preventing thermal stress failure in microelectronic devices.
Prize worthiness: Major contribution to electronic packaging reliability; IEEE CPMT Society Award.
Recognition received: AFOSR-funded; known in microelectronics reliability community.
Recognition deserved: Inclusion in microelectronics packaging textbooks.
Related works: Publications in Journal of Applied Physics (1994–1995).

{XII} Solved the long-standing problem of an isolated rigid fiber in an elastic space

Solved the long-standing problem of an isolated rigid fiber in an elastic space (1983) attacked earlier by Larmor, Van Dyke, Landau, Lifshitz and Eshelby. The method developed for solving this problem was applied to problems of pull-out, push-in, and many other related problems of slender bodies (in publications of 1983, 1985, 1987, 1988, 1995). Cherepanov also obtained the exact solution for extension of an elastic space with an isolated stiff rod (1985), providing the stress distribution around the fiber, the load
transfer mechanism, and the effective stiffness of the composite.

Impact: Solved a long-standing problem in elasticity theory; provided exact solutions for fiber-reinforced composites.
Prize worthiness: Major contribution to composite mechanics; ASC Best Paper Award.
Recognition received: Known in composite mechanics circles.
Recognition deserved: Inclusion in composite materials textbooks.
Related works: "Solution of the isolated rigid fiber problem" (1983); "Extension of an elastic space with an isolated stiff rod" (1985); subsequent works on slender bodies (1985 –1995).

{XIII} Developed an approach to the localization of plastic deformation into shear bands using the selection principle based on the concept of maximum energy dissipation rate

Developed an approach to the localization of plastic deformation into shear bands using the selection principle based on the concept of maximum energy dissipation rate (1975). The concept was later applied by Slepyan to dynamic problems. This principle selects the configuration that dissipates energy most rapidly among all possible configurations, determining which shear band orientation and spacing occurs naturally.
Impact: Provided a predictive criterion for localization of plastic deformation, bridging continuum plasticity and material failure.
Prize worthiness: A major contribution to plasticity and mesomechanics, worthy of a Nadai Medal (ASME) or William Prager Medal (Society of Engineering Science).
Recognition received: Known in specialist literature; concept applied by others.
Recognition deserved: Broader acknowledgment in plasticity textbooks.
Related works: "On the problem of non-uniqueness in the theory of plasticity" (1974); subsequent papers on energy dissipation principles.

{XIV} Introduced the theory of fluidization of particulate media

Introduced the theory of fluidization of particulate media (with Gupalo and Galin) that has found an application to design of chemical reactors (1969-1978). This provided the first rigorous mathematical theory for fluidized bed reactors, including particle motion, pressure drop, and bed expansion. Fluidized bed reactors are used throughout the chemical and petroleum industries for catalytic cracking, pharmaceutical manufacturing, and coal gasification.
Impact: Provided the first rigorous mathematical theory for fluidization, transforming chemical engineering practice.
Prize worthiness: Major contribution to chemical engineering; Founders Award (AIChE).
Recognition received: Known in chemical engineering literature; the theory is used in reactor design.
Recognition deserved: Inclusion in chemical engineering textbooks and recognition as a foundational theory.
Related works: "The theory of fluidization, Parts 1 and 2" (1972); collaborative works with Gupalo and Galin (1969–1978).

{XV} Introduced the theory of explosion effect in brittle materials

Introduced the theory of explosion effect in brittle materials as the counterpart to the theory of Taylor and Grigorian for plastic materials. Cherepanov derived the relationships between explosive charge, fracture zone size, and material properties (rock, concrete, glass), applying fracture mechanics principles to blast-induced cracking.
Impact: Extended explosion physics from ductile to brittle materials, completing the theoretical framework.
Prize worthiness: Deserving of a major award in the field of shock physics or blasting engineering, such as the George Taylor Medal (Society of Engineering Science) or the ASME Impact Mechanics Award.
Recognition received: Known in mining engineering literature.
Recognition deserved: Inclusion in blasting engineering textbooks.
Related works: "Theory of explosion effect in brittle materials" (1977–1979); Rock Fracture Mechanics in Drilling (1987).

{XVI} Developed methods of the functionally-invariant Smirnov-Sobolev's solutions in dynamic elasticity and acoustics

Developed methods of the functionally-invariant Smirnov-Sobolev's solutions in dynamic elasticity and acoustics (with Afanasiev). These methods provide analytical solutions for wave propagation problems in elastic media and acoustic fields, extending the classical Smirnov-Sobolev approach to more complex boundary conditions and material properties.
Impact: Advanced analytical methods for dynamic elasticity and acoustics.
Prize worthiness: A contribution to applied mathematics and wave propagation theory, deserving of recognition at the level of the George David Birkhoff Prize (SIAM) or the ASME Wave Mechanics Award.
Recognition received: Known in specialist literature.
Recognition deserved: Broader acknowledgment in wave propagation textbooks.
Related works: Collaborative works with Afanasiev on functionally-invariant solutions.

{XVII} Proved that failure criteria for brittle materials are generally path-dependent and do not meet Drucker's postulate

Proved that failure criteria for brittle materials are generally path-dependent and do not meet Drucker's postulate (with Germanovich, 1987-1995). The mathematical theory of catastrophe was used to achieve the result. Catastrophe theory (developed by René Thom) describes how small changes in control parameters can cause sudden, discontinuous changes in system behavior. Cherepanov applied it to fracture mechanics to explain the sudden, discontinuous nature of brittle fracture. This proved that brittle failure is inherently a catastrophic phenomenon that cannot be described by classical plasticity stability conditions.
Impact: Proved that brittle failure criteria are path-dependent and cannot be described by classical plasticity stability conditions.

Prize worthiness: A fundamental contribution to theoretical fracture mechanics and applied mathematics, deserving of recognition at the level of the Timoshenko Medal (ASME) or the Norbert Wiener Prize in Applied Mathematics (SIAM).
Recognition received: Moderate; known in specialist fracture literature.
Recognition deserved: Broader recognition in applied mathematics and mechanics.
Related works: "Employment of the catastrophe theory in fracture mechanics as applied to brittle strength criteria" (1994); collaborative works with Germanovich (1987–1995).

{XVIII} Contributed to optimal design by generalizing the concept of equistrength, introduced by Galileo Galilei, for arbitrary structures

Contributed to optimal design by generalizing the concept of equistrength, introduced by Galileo Galilei, for arbitrary structures. Predicted many equistrong configurations, e.g. equistrong turbine blades, equistrong rotating disks, equistrong holes, equistrong underground tunnel shapes, etc., using this concept (1962-1995). The work was continued by Wheeler (as applied to minimum stress concentration), Banichuk, Vigdergauz, Alimzhanov and other investigators (supported by ARO grant). Cherepanov generalized Galileo's equistrength principle for arbitrary structures and developed mathematical methods to design equistrong configurations — structures where every point is equally stressed at failure.
Impact: Transformed a qualitative principle into a quantitative design methodology applicable to any structure.
Prize worthiness: Major contribution to structural optimization; ASME Melville Medal.
Recognition received: Moderate; the concept is known but not widely applied in industry.
Recognition deserved: Broader adoption in engineering design textbooks and practice.
Related works: Papers on equistrong design (1962–1995); Chapter on optimal design in Invariant Integrals in Physics (2019).

{XIX} Introduced the theory of gas grifons around boreholes and erosion of fluid-infiltrated solids under dams

Introduced the theory of gas grifons around boreholes and erosion of fluid-infiltrated solids under dams (1987). Cherepanov derived the driving force for pressurized cylindrical crack (gryphon) propagation using the invariant integral, including the effects of rock permeability, gas pressure, and casing elasticity. This theory explains how small, undetected cracks can suddenly accelerate and cause blowouts.
Impact: Provided quantitative understanding of a previously mysterious industrial disaster mechanism.
Prize worthiness: Major safety engineering award.
Recognition received: Limited outside specialist circles.
Recognition deserved: Inclusion in petroleum engineering safety training.

Related works: "Theory of gas gryphons around boreholes and erosion of fluid-infiltrated solids under dams" (1987); Chapter 6 of Invariant Integrals in Physics (2019).

{XX} Contributed to penetration mechanics

Contributed to penetration mechanics (1985, 1987, 1994). His work includes the super-penetration effect of thin wing-shaped penetrators (1994-95) and applications of fracture mechanics to high-speed impact problems, including the collision of a bullet with a membrane (2022).
Impact: Advanced understanding of high-speed penetration and impact mechanics.
Prize worthiness: A major contribution to high-speed impact and penetration mechanics, including the discovery of the super-penetration effect of thin wing-shaped penetrators; deserving of recognition at the level of the Hypervelocity Impact Society Award or the ASME Solid Mechanics Medal.
Recognition received: Limited.
Recognition deserved: Broader acknowledgment in impact mechanics.
Related works: Publications in Journal of Applied Mechanics, Engineering Fracture Mechanics, Mechanics of Materials (1994–1995); Rock Fracture Mechanics in Drilling (1987); "Collision of a bullet with a membrane" (2021).

{XXI} Introduced the theory of hydrogen embrittlement and corrosion fracture

Introduced the theory of hydrogen embrittlement and corrosion fracture (1972-1981). Cherepanov developed a quantitative theory using the invariant integral approach, modeling how hydrogen atoms diffuse to crack tips, reduce the cohesive strength of atomic bonds, and promote brittle fracture under stresses that would normally cause ductile behavior.
Impact: Provided a mechanistic framework for understanding environment-assisted cracking.
Prize worthiness: Major award in corrosion science or materials engineering.
Recognition received: Moderate; the field remains active but his specific contributions are not widely cited.
Recognition deserved: Inclusion in corrosion engineering textbooks.
Related works: Papers on hydrogen embrittlement and corrosion fracture (1972–1981); Fracture Mechanics (2012).

{XXII} Introduced the theory of fatigue crack growth

Introduced the theory of fatigue crack growth (1968-1978). Cherepanov derived analytical expressions for crack growth per cycle based on the invariant integral and plastic deformation accumulation at the crack tip: $dL/dn = (1/2)\beta(\Gamma max/\Gamma IC)2$ for small loads, and a more general form for all loading ranges. He introduced the threshold condition for fatigue crack propagation based on his nanofracture mechanics theory: $\Gamma F/\Gamma IC = \sqrt{(2a/\beta)}$ where a is the interatomic spacing.

Impact: Provided first principles foundation for fatigue crack growth prediction.
Prize worthiness: Development of the first analytical theory of fatigue crack growth from first principles, including the derivation of the crack growth per cycle equation and the threshold condition for propagation; deserving of recognition at the level of the Nadai Medal (ASME) or the Fracture Mechanics Award (ASTM).
Recognition received: Moderate; the field is dominated by empirical approaches.
Recognition deserved: Inclusion in fatigue mechanics textbooks.
Related works: "On the crack growth under cyclic loadings" (1968); "On the theory of fatigue crack growth" (1972, with Halmanov); Chapter 8 of Invariant Integrals in Physics (2019).

{XXIII} Contributed to contact and mixed problems of the theory of elasticity

Contributed to contact and mixed problems of the theory of elasticity (1963-95). His most significant contribution in this area is the solution of the general contact problem with stick and slip areas (2015), which solved a century-old problem unsolved by Hertz (1882), Muskhelishvili (1953), and Galin (1953). Cherepanov introduced the brittleness number λ that separates plastic flow
($\boldsymbol{\lambda << 1}$, stable slip growth) from brittle fracture ($\boldsymbol{\lambda >> 1}$, unstable slip development). He also derived the frontal resistance force on a moving punch: $\boldsymbol{\Gamma_x = -(1-\nu^2)K^2/E}$.
Impact: The foundation of theoretical tribology.
Prize worthiness: Tribology Gold Medal; ASME Mayo D. Hersey Award.
Recognition received: Minimal; cited in fracture mechanics but not widely in tribology.
Recognition deserved: Inclusion in tribology textbooks and reference works.
Related works: "The contact problem of the mathematical theory of elasticity with stick and slip areas" (2015); "Some new applications of the invariant integrals in mechanics" (2012); Chapter 5 of Invariant Integrals in Physics (2019).

{XXIV} Discovered an ample class of boundary problems of the theory of elasticity, in which the Saint-Venant's principle is not satisfied

Discovered an ample class of boundary problems of the theory of elasticity, in which the Saint-Venant's principle is not satisfied (1970). Cherepanov classified these as "N-singularities" — problems where the resultant force and moment at infinity are infinite, yet the local stress field is well-defined and physically meaningful. This fundamentally changed understanding of elasticity theory.
Impact: Fundamentally changed understanding of elasticity theory; showed that many practical problems require different mathematical treatment than classical Saint-Venant approach.
Prize worthiness: A fundamental result demonstrating that Saint-Venant's principle is not universal, and discovering a new class of 'N-singularities' in elasticity theory; worthy of a major international award in theoretical mechanics, such as the Timoshenko Medal (ASME) or the William Prager Medal (Society of Engineering Science).
Recognition received: Known within specialist circles but not widely appreciated.
Recognition deserved: Broader recognition in elasticity textbooks.

Related works: "Singular solutions in the theory of elasticity" (1970); "Some problems concerning the unknown body boundaries in the theory of elasticity and plasticity" (1965).

{XXV} Developed the Eshelby's theory of point defects in solids

Developed the Eshelby's theory of point defects in solids (1984-1995). Cherepanov extended Eshelby's theory to describe the motion of point defects under stress gradients, deriving governing equations for defect drift and diffusion in elastic fields. This included the motion of interstitial atoms, vacancies, and foreign inclusions in crystal lattices.
Impact: Extended Eshelby's theory to include motion and migration of defects, providing a unified framework for defect dynamics.
Prize worthiness: Extension of Eshelby's theory of point defects, including the derivation of governing equations for defect drift and migration under stress gradients, providing a unified framework for defect dynamics in solids; deserving of recognition at the level of the Von Hippel Award (Materials Research Society) or the American Physical Society's Prize in Solid State Physics.
Recognition received: Known in solid state physics literature.
Recognition deserved: Inclusion in materials science textbooks.
Related works: "The motion of point defects in solids" (1986); Chapter 5 of Methods of Fracture Mechanics: Solid Matter Physics (1997).

{XXVI} Introduced the theory of rock cutting

Introduced the theory of rock cutting (1987). Cherepanov derived the force required for a cutting tool to propagate a crack in rock, relating cutting force to rock fracture toughness, tool geometry, and confining pressure. This applied fracture mechanics to drilling and excavation.
Impact: Applied fracture mechanics to drilling and excavation — a new approach.
Prize worthiness: The first analytical theory of rock cutting, linking cutting force to rock fracture toughness, tool geometry, and confining pressure — and applying fracture mechanics to drilling and excavation; deserving of recognition at the level of the Anthony F. Lucas Gold Medal (SPE) or the ASME Applied Mechanics Award.
Recognition received: Limited; the field remains empirically driven.
Recognition deserved: Inclusion in drilling engineering textbooks.
Related works: Rock Fracture Mechanics in Drilling (1987); Chapter 7 of Invariant Integrals in Physics (2019).

{XXVII} Developed classical fracture mechanics

Developed classical fracture mechanics, namely:
a. Derived, with Barenblatt, energy release rate in terms of stress intensity factors for arbitrary mixed-mode cracks (co-derived by Irvin, Kies and some other investigators).

Impact: Foundational to mixed-mode fracture mechanics.

Recognition deserved: Acknowledgment in standard fracture mechanics texts.

b. Discovered, with Barenblatt, that the limiting speed of crack propagation in a homogeneous material is the Rayleigh speed (co-discovered by Broberg, Stroh, Wells and others).

Impact: Established the fundamental speed limit for cracks.

Recognition deserved: Inclusion in dynamic fracture mechanics textbooks.

c. Developed useful solutions for bimaterial interface cracks later re-discovered by England, Rice, Sih, Hutchinson, Suo, Salganik and other investigators.

Impact: Provided analytical tools for interfacial fracture mechanics.

Recognition deserved: Acknowledgment of priority in interface fracture literature.

d. Pioneered, with Barenblatt, the theory of cracks in anisotropic materials. (This work was co-pioneered by Stroh).

Impact: Extended fracture mechanics to anisotropic media, essential for composites.

Recognition deserved: Inclusion in composite fracture mechanics textbooks.

e. Developed fractal fracture mechanics, with Balankin and Ivanova (1996). This theory accounts for the self-similar, fractal nature of real crack surfaces, connecting macroscopic fracture energy to the fractal dimension of the crack surface.

Impact: Bridged fractal geometry and fracture mechanics.

Prize worthiness: Creation of fractal fracture mechanics, linking macroscopic fracture energy to the fractal dimension of the crack surface and accounting for the self-similar nature of real fracture surfaces; deserving of recognition at the level of the Von Hippel Award (Materials Research Society) or the ASME Applied Mechanics Award.

Recognition received: Known in fractal mechanics community.

Recognition deserved: Broader acknowledgment in fracture mechanics.

Related works: "Fractal fracture mechanics" (1996, with Balankin and Ivanova).

f. Developed creep crack growth theory in metals (1974-1987).

Impact: Provided theoretical foundation for time-dependent fracture at high temperatures.

Recognition deserved: Inclusion in high-temperature fracture mechanics texts.

g. Introduced the theory of delamination of laminate structures and shells (1983).

Impact: Essential for composite materials design and failure prediction.

Recognition deserved: Inclusion in composite materials textbooks.

h. Developed the theory of crack nucleation in metals (in particular, according to Cottrell's mechanism).

Impact: Bridged dislocation theory and fracture initiation.

Recognition deserved: Acknowledgment in physical metallurgy texts.

i. Developed fracture mechanics of composite materials (1983).

Impact: Extended fracture mechanics to heterogeneous, anisotropic materials.

Recognition deserved: Inclusion in composite materials design textbooks.

j. Developed fracture mechanics of rocks (1987).

Impact: Applied fracture mechanics to geotechnical engineering and mining.

Recognition deserved: Inclusion in rock mechanics textbooks.

k. Derived equation of energy release rate in terms of stress intensity factor for a fast propagating crack (1968). This equation was simultaneously co-discovered by Eshelby, Atkinson, Kostrov, Freund and others.

Impact: Provided the foundation for dynamic fracture mechanics.

Recognition deserved: Inclusion in standard histories of dynamic fracture mechanics.

Additional foundational works: His 1990 paper "Construction of fracture mechanics" integrated the mathematical foundations of fracture mechanics into a unified discipline. His 1997 monograph Methods of Fracture Mechanics: Solid Matter Physics provided the most comprehensive integration of fracture mechanics with solid state physics, covering surface energy of solids, fluctuations and kinetic theory of fracture, crack nucleation, physics of sintering, point defects in solids, dislocation emission (nanofracture mechanics), relativistic electron beams in a solid, and fractals in fracture of solids. Cherepanov also served as editor of Fracture: A Topical Encyclopedia of Current Knowledge (1998), an 870-page reference work covering all aspects of fracture.
Impact: Established the modern mathematical structure of fracture mechanics as a coherent discipline; provided definitive references for the field.
Prize worthiness: Nadai Medal (ASME), Von Hippel Award (Materials Research Society), Timoshenko Medal.
Recognition received: The monograph is cited in zbMATH and used in graduate courses, but its full significance is not widely appreciated.
Recognition deserved: Recognition as a classic text in fracture physics, alongside Griffith, Irwin, and Eshelby.
Related works: "Construction of fracture mechanics" (1990); Methods of Fracture Mechanics: Solid Matter Physics (1997); Fracture: A Topical Encyclopedia of Current Knowledge, editor (1998).

{XXVIII} Developed the mathematical theory of progressive collapse of tall buildings

Developed the mathematical theory of progressive collapse of tall buildings, demonstrating that progressive collapse is significantly slower than free fall. Applied this theory to the collapse of the World Trade Center towers in New York on September 11, 2001, concluding that the collapse initiation occurred on floors located considerably below those directly affected by the fires resulting from the terrorist aircraft impacts (2005–2007).
Impact: Applied fracture mechanics principles to structural engineering and disaster analysis; provided quantitative criteria for distinguishing collapse modes.
Prize worthiness: The development of the mathematical theory of progressive collapse of tall buildings, including a quantitative analysis of the relationship between progressive collapse velocity and free fall, and the application of this theory to the analysis of the World Trade Center collapse on September 11, 2001. This contribution opened a new direction in the application of fracture mechanics to structural engineering and deserves recognition at the level of the Newmark Medal (ASCE) or the ASME Structural Mechanics Award.
Recognition received: Controversial; the conclusions about the WTC collapse have been disputed.
Recognition deserved: Recognition as a novel application of fracture mechanics to structural collapse.

Related works (chronological order):
"September 11 and fracture mechanics." Int. J. Fracture, 132(2), pp. L25-L26, 2005.
"Mechanics of the WTC collapse." Int. J. Fracture, 141, pp. 287-289, 2006.
"Equistrong tower." Int. J. Engineering and Automation Problems, v. 5, No. 1, pp. 100-103, 2006.
"Mechanics of avalanches and the WTC collapse" (with I.E. Esparragoza). Paper at the US National Congress on Theoretical and Applied Mechanics, June 2006, Colorado.
"Progressive collapse of towers: the resistance effect." Int. J. Fracture, 143, pp. 203-206, 2007.
"On self-sustaining fracture waves" (with I.E. Esparragoza). Int. J. Fracture, 144, pp. 197-202, 2007.
"Destruction mechanics: self-destruction" (with I.E. Esparragoza). Int. J. Applied Mechanics and Engineering, v.12, no.2, pp. 565-570, 2007.
"An entrainment model of snow avalanches" (with I.E. Esparragoza). J. Glaciology, 54(184), pp. 182-189, 2008.
"Progressive collapse of towers: the hybrid model" (with I.E. Esparragoza). J. Appl. Mech. Eng., 12(3), pp. 575-585, 2008.

{XXIX} Engaged in dissident scholarship and samizdat publications during the glasnost era (1987–1989)

Engaged in dissident scholarship and samizdat publications during the glasnost era (1987–1989), risking personal freedom to speak truth to power. Cherepanov published articles in independent political magazines, addressed an open letter to President Gorbachev, wrote on the spiritual legacy of Solzhenitsyn, and developed mathematical models of social justice, labor migration, and political stability. His samizdat writings reveal a scientist of conscience — one who applied mathematical thinking to the problems of human society and dared to criticize the Soviet system.
Impact: Reveals a previously unknown dimension of Cherepanov's legacy — his courage as a public intellectual and dissident.
Prize worthiness: Cherepanov deserves recognition as a scholar of conscience and a dissident intellectual who risked his freedom for truth.
Recognition received: Limited — these works were samizdat, not widely known in the West.
Recognition deserved: Inclusion in the history of Soviet dissident science and intellectual resistance.
Related works: "Need we in sociology?" (1989); "Why have we the largest army in the world?" (1989); "A.I. Solzhenitsyn and the task of spiritual clearing of this society" (1989); "Open letter to President Gorbachov" (1989); "The mathematical model of social justice and stability" (1987); "What is the future of the new autocracy?" (1989); "Secret war of KGB against dissidents" (1989); "The informational/mathematical model of motion of labor" (1988, with L.Ya. Cherepanova); "Mathematical sociology of motion of labor" (1987, with L.Ya. Cherepanova); "The mathematical theory of migration" (1988, with L.Ya. Cherepanova).

Summary of Scientific Legacy

Dr. Cherepanov contributed to at least 17 major scientific fields and approximately 91 distinct subfields, ranging from pure mathematics and fracture mechanics to geophysics, cosmology, political science, and mathematical sociology. Based on the significance of his discoveries — including the invariant integral, nanofracture mechanics (as founder), the analytical theory of rolling friction (solving a 200-year-old problem), the complete theory of hydraulic fracturing, and the solution of the Hertz-Muskhelishvili stick-slip problem — he was deserving of multiple major international awards, including the Nobel Prize in Physics, the Timoshenko Medal, the Tribology Gold Medal, and the Anthony F. Lucas Gold Medal. Unfortunately, due to a combination of Cold War-era publication isolation, priority disputes (J-integral, also denoted Γ-integral in Cherepanov's original work, and HRR), a lack of inclination toward self-promotion, and unconventional later positions (NEOC cosmology, WTC collapse analysis), he did not receive the vast majority of these honors. Genady Cherepanov received the Lenin Komsomol Prize (1972) and the Fulbright Prize (2000), but these represent only a small fraction of the recognition his body of work deserved.

17 major fields and 91 subfields of scientific contributions by Dr. Genady P. Cherepanov

1. PURE AND APPLIED MATHEMATICS

#	Subfield	Reference Work
1.1	Complex analysis (Riemann-Hilbert problems)	"A non-linear problem in the theory of analytical functions" (1962); "The Riemann–Hilbert problem for cuts along a straight line or circumference" (1964)
1.2	Functional equations and analytic continuation	"Boundary value problems with analytical coefficients" (1965); "A method of solving elastic-plastic problems" (1963)
1.3	Singular integral equations (Cauchy and Hilbert kernels)	"The Riemann-Hilbert problem of a plane with cuts" (1964)
1.4	Boundary value problems (mixed and free-boundary)	"Some problems of the theory of elasticity and plasticity with unknown boundaries" (1965)
1.5	Fractal geometry	"Fractal fracture mechanics" (with Balankin and Ivanova, 1995)
1.6	Catastrophe theory	"Employment of the catastrophe theory in fracture mechanics" (with Germanovich, 1993)
1.7	Conformal mapping and complex potentials	*Mechanics of Brittle Fracture* (1979); "Stresses in an inhomogeneous plate having slits" (1962)
1.8	Numerical methods (finite elements, finite differences)	"A computerized model for thermal stresses in thin films" (with Martinez, 1997)

2. SOLID MECHANICS AND ELASTICITY

#	Subfield	Reference Work
2.1	Theory of elasticity (general)	*Methods of Fracture Mechanics: Solid Matter Physics* (1997); "Singular solutions in the theory of elasticity" (1970)
2.2	Anisotropic elasticity	"On equilibrium and propagation of cracks in an anisotropic medium" (with Barenblatt, 1961)
2.3	Thermoelasticity	"On the theory of thermal stresses in a thin film on a ceramic substrate" (1994)
2.4	Contact and mixed problems	"The contact problem of the mathematical theory of elasticity with stick and slip areas" (2015)
2.5	Saint-Venant's principle (N-singularities)	"Singular solutions in the theory of elasticity" (1970)
2.6	Elastic-plastic problems	"Elastic-plastic problems of anti-plane strain" (1962); *Elastic-Plastic*

#	Subfield	Reference Work
		Problems (with Annin, 1988)
2.7	Local buckling and stability	"Buckling of membranes with holes under extension" (1963)
2.8	Residual and thermal stresses	"On the theory of thermal stresses in a thin bonding layer" (1995)

3. FRACTURE MECHANICS (CORE CONTRIBUTION)

#	Subfield	Reference Work
3.1	Invariant Γ-integral (path-independent)	"On crack propagation in continuous media" (1967)
3.2	Dynamic fracture mechanics	"On crack propagation in continuous media" (1967); "Cracks in solids" (1968)
3.3	Elastic-plastic fracture (HRR priority)	"On crack propagation in continuous media" (1967)
3.4	Interface and bimaterial cracks	"On the arrest of a crack impinging an interface" (with Rabotnov and Kuliev, 1978)
3.5	Mixed-mode fracture	"Energy release rate for arbitrary mixed-mode cracks" (with Barenblatt)
3.6	Fatigue crack growth	"On the theory of fatigue crack growth" (with Halmanov, 1972); Chapter 8 of *Invariant Integrals in Physics* (2019)
3.7	Creep crack growth	"Creep cracks" (with A.G. Cherepanov, 1987)
3.8	Crack nucleation	"Interface microcrack nucleation" (1994)
3.9	Delamination and laminate fracture	"Fracture mechanics of laminate shells. The theory of delamination" (1983)
3.10	Fracture of composite materials	*Fracture Mechanics of Composite Materials* (1983)
3.11	Fracture of rocks	*Rock Fracture Mechanics in Drilling* (1987); *Fracture Mechanics of Rocks during Outburst* (1987)
3.12	Fractal fracture mechanics	"Fractal fracture mechanics" (with Balankin and Ivanova, 1995)
3.13	Corrosion and hydrogen embrittlement	"On the theory of crack growth due to hydrogen embrittlement" (1973)
3.14	Fracture criteria (path-dependent)	"On some general properties of strength criteria" (with Germanovich, 1995)
3.15	Crack tip singularity analysis	"On the finiteness of stresses at a crack-tip" (with Barenblatt, 1961)

4. NANOMECHANICS AND MATERIALS SCIENCE

#	Subfield	Reference Work
4.1	Nanofracture mechanics (founder)	"On the foundation of fracture mechanics: fatigue and creep cracks in quantum fracture mechanics" (1990)
4.2	Quantum fracture mechanics	"Quantum fracture mechanics" (1990)
4.3	Dislocation emission theory	"The initiation of microcracks and dislocations" (1987); "Dislocation generation and crack growth under monotonic loading" (with Richter et al., 1995)
4.4	Brittleness number ($\eta = k_1/k_IC$)	"On the foundation of fracture mechanics" (1990)
4.5	Point defects (Eshelby theory extension)	"Point defects in solids" (1984); "Motion of point defects in solids" (1986)
4.6	Surface energy of solids	Chapter 1 of *Methods of Fracture Mechanics: Solid Matter Physics* (1997)
4.7	Sintering physics	Chapter 4 of *Methods of Fracture Mechanics: Solid Matter Physics* (1997)
4.8	Fracture of protection coatings and films	"Fracture mechanics of protection coatings and films" (with A.G. Cherepanov, 1988)

5. TRIBOLOGY AND CONTACT MECHANICS

#	Subfield	Reference Work
5.1	Analytical theory of rolling friction (Coulomb problem solved)	"Theory of rolling: solution of the Coulomb problem" (2014); Chapter 3 of *Invariant Integrals in Physics* (2019)
5.2	Stick-slip problem (Hertz-Muskhelishvili solved)	"The contact problem of the mathematical theory of elasticity with stick and slip areas" (2015)
5.3	Adhesion mechanics	"The strength of adhesion" – Chapter 5 of *Invariant Integrals in Physics* (2019)
5.4	Frontal resistance force of moving punch	"Some new applications of the invariant integrals of mechanics" (2012)

6. FLUID DYNAMICS AND GAS DYNAMICS

#	Subfield	Reference Work
6.1	Fluidization theory	"On the theory of fluidization – Part 1 & 2" (1972); "The plane problem of fluidization" (with Gupalo, 1967)
6.2	Hydrodynamics (free-surface flows)	"The flow of an ideal fluid with free surfaces" (1964)

#	Subfield	Reference Work
6.3	Gas dynamics	"On the theory of normal velocity of combustion" (1965)
6.4	Optimal airfoil theory	Chapter 4 of *Invariant Integrals in Physics* (2019)
6.5	Convective heat/mass transfer	"Two-dimensional convective heat/mass transfer for low Prandtl and any Peclet numbers" (1998)
6.6	Vortex and separated flows	*Two-Dimensional Separated Flows* (1993, editor)

7. GEOPHYSICS AND EARTH SCIENCES

#	Subfield	Reference Work
7.1	Fault mechanics	"On modeling of the earthquake focus" (with Bykovtsev, 1980)
7.2	Earthquake mechanics	"A model of tectonic earthquakes" (with Bykovtsev, 1980)
7.3	Rock cutting theory	"The theory of rock cutting" (1986); *Rock Fracture Mechanics in Drilling* (1987)
7.4	Gas gryphons (cylindrical cracks)	"Theory of gas gryphons around boreholes and erosion" (1987)
7.5	Landslide mechanics	"On modeling of closed landslides" (with Bykovtsev, 1985)
7.6	Stress accumulation around faults	"Configurational forces in solid mechanics" (1985)

8. COSMOLOGY AND ASTROPHYSICS

#	Subfield	Reference Work
8.1	NEOC cosmology model	Chapter 11 of *Invariant Integrals in Physics* (2019); "A neoclassic approach to cosmology" (2017)
8.2	Dark energy as centrifugal force	"The invariant integral of physical mesomechanics" (2015); Chapter 11 of *Invariant Integrals in Physics* (2019)
8.3	Galactic rotation velocity ($V = \sqrt{(kG)}$)	"The large-scale universe: The past, the present and the future" (2016)
8.4	Fractal universe model	"The large-scale universe: The past, the present and the future" (2016)
8.5	Age of the universe (12.3 billion years)	Chapter 11 of *Invariant Integrals in Physics* (2019)

9. ELECTRODYNAMICS AND RELATIVISTIC PHYSICS

#	Subfield	Reference Work
9.1	Generalized Coulomb law (CBC law)	"Theory of the electron fracture mode in solids" (with Borzykh, 1993)
9.2	Relativistic electron beams	"Brittle fracture of solids by intense electron beams" (with Borzykh, 1993)
9.3	Electromagnetic invariant integrals	"Invariant integrals in continuum mechanics" (1990); Chapter 10 of *Invariant Integrals in Physics* (2019)
9.4	Superluminal charge interaction	"The invariant integral: some news" (2013)

10. IMPACT AND PENETRATION MECHANICS

#	Subfield	Reference Work
10.1	Super-penetration effect	"Super-deep penetration" (1994); "An analysis of two models of superdeep penetration" (1996)
10.2	Rayleighon (self-propagating solitary wave)	"Rayleighons" (1994)
10.3	Collision of bullet with membrane	"Collision of a bullet with a membrane" (2021)
10.4	Macro-super-penetration	"Macro-Super-Penetration" (1997)

11. EXPLOSION AND SHOCK PHYSICS

#	Subfield	Reference Work
11.1	Explosion in brittle materials	"Theory of explosion effect in brittle materials" (1977–1979)
11.2	Self-maintained failure waves (with Galin)	"On the self-maintaining fracture of high-stressed brittle bodies" (with Galin, 1966)
11.3	Structural bond energy release	"Self-maintained failure waves" (with Galin, 1967)
11.4	Fracture waves (general theory)	Appendix 1 of "On the Collapse of the World Trade Center" (2006); *Mechanics of Brittle Fracture* (1979)
11.5	WTC collapse analysis	"Mechanics of the WTC collapse" (2006); "Progressive collapse of towers: the resistance effect" (2007)

12. STRUCTURAL OPTIMIZATION AND DESIGN

#	Subfield	Reference Work
12.1	Equistrong design (Galileo generalized)	"Equistrong heavy beam: Solving the problem of Galileo Galilei" (2016)
12.2	Equistrong turbine blades, disks, tunnels	"Optimum Shapes of Elastic Bodies" (2015)
12.3	Optimal structural design theory	"Weight versus strength: a case study" (1995)
12.4	Optimal design of composite panels	"On optimal design of multi-layered panels" (with Smolsky, 1978)

13. ACOUSTICS AND WAVE PROPAGATION

#	Subfield	Reference Work
13.1	Functionally-invariant Smirnov-Sobolev solutions	"Self-similar problems of dynamic elasticity" (with Afanasiev, 1970)
13.2	Dynamic elasticity and wave propagation	"Some dynamic problems of the theory of elasticity" (with Afanasiev, 1974)

14. CHEMICAL ENGINEERING

#	Subfield	Reference Work
14.1	Fluidized bed reactors	"On the theory of fluidization – Part 1 & 2" (1972)
14.2	Catalytic cracking	"The continuum theory of fluidization" (with Galin and Gupalo, 1978)

15. MICROELECTRONICS AND THERMAL STRESSES

#	Subfield	Reference Work
15.1	Thermal stresses in thin films	"On the theory of thermal stresses in a thin film on a ceramic substrate" (1994)
15.2	Thermal stresses in bonding layers	"On the theory of thermal stresses in a thin bonding layer" (1995)
15.3	Computerized model for thermal stresses	"A computerized model for thermal stresses in thin films" (with Martinez, 1997)

16. POLITICAL SCIENCE AND SOCIOLOGY

#	Subfield	Reference Work
16.1	Samizdat publications	"Need we in sociology?" (1989); "Why have we the largest army in the world?" (1989)
16.2	Mathematical models of social justice	"The mathematical model of social justice and stability" (1987)
16.3	Mathematical theory of migration	"The mathematical theory of migration" (with L.Ya. Cherepanov, 1988)
16.4	Open letter to Gorbachev	"Open letter to President Gorbachov" (1989)

17. MATHEMATICAL SOCIAL SCIENCES

#	Subfield	Reference Work
17.1	Mathematical sociology of labor	"Mathematical sociology of motion of labor" (with L.Ya. Cherepanov, 1987)
17.2	Informational/mathematical model of labor	"An informational/mathematical model of the motion of labor" (with L.Ya. Cherepanov, 1989)
17.3	Mathematical model of totalitarian societies	"Mathematical model of totalitarian autocratic societies" (in revision, ca. 1995)

Summary Table

#	Field	Subfields
1	Pure and Applied Mathematics	8
2	Solid Mechanics and Elasticity	8
3	Fracture Mechanics	15
4	Nanomechanics and Materials Science	8
5	Tribology and Contact Mechanics	4
6	Fluid Dynamics and Gas Dynamics	6
7	Geophysics and Earth Sciences	6
8	Cosmology and Astrophysics	5
9	Electrodynamics and Relativistic Physics	4
10	Impact and Penetration Mechanics	4
11	Explosion and Shock Physics	5

#	Field	Subfields
12	Structural Optimization and Design	4
13	Acoustics and Wave Propagation	2
14	Chemical Engineering	2
15	Microelectronics and Thermal Stresses	3
16	Political Science and Sociology	4
17	Mathematical Social Sciences	3

TOTAL: 17 Major Fields, 91 Subfields

Publications

Books »»

Invariant Integrals in Physics, Springer, 2019, 259 p.
Fracture: A Topical Encyclopedia of Current Knowledge (sole Editor), Krieger Publ., Melbourne, 1998, 890 p.
Mechanics of Brittle Fracture, McGraw Hill, New York, 1979, 950 p.
Methods of Fracture Mechanics: Solid Matter Physics, Kluwer Publ., Dordrecht, 1997.
Elastic-Plastic Problems, ASME, New York, 1988 (with B.D. Annin).
Rock Fracture Mechanics in Drilling, Moscow, Nedra, 1987 (in Russian).
Fracture Mechanics of Rocks in Drilling Processes, Moscow, Nedra, 1987, 307 p. (in Russian).
Fracture Mechanics of Composite Materials, Moscow, Nauka, 1983 (in Russian).
Elastic-Plastic Problem, Novosibirsk, Nauka, 1983, 238 p. (with B.D. Annin, in Russian).
Fracture Mechanics, Moscow, Mashinostroenie, 1977, 224 p. (with L.V. Ershov, in Russian).
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Mathematical Foundations of Rock Mass Modeling, Moscow, MGI, 1977, 80 p. (with L.V. Ershov, in Russian).
Methods of Solving Rock Mechanics Problems, Moscow, MGI, 1976, 94 p. (with L.V. Ershov, in Russian).
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Mechanics of Brittle Fracture, Moscow, Nauka, 1974, 640 p. (in Russian).
Fracture and Fatigue (Russian Edition Editor), Moscow, MIR, 1978 — Translated from Composite Materials, Vol. 5 (Ed. L. J. Broutman), Academic Press, 1974.
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"Fracture Mechanics", in Anniversary Volume: Mechanics in the USSR for Fifty Years, V. 3, Moscow, Nauka, 1972 (with V. Z. Parton, in Russian).

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On the influence of body boundaries on the development of brittle cracks (with G.L. Barenblatt), Notices of the USSR Academy of Sciences, 1960, N.3.
On wedging of brittle bodies (with G. I. Barenblatt), Appl. Math. and Mech. (PMM), 1960, V.24, N.4.
On equilibrium and propagation of cracks in an anisotropic medium (with G. I. Barenblatt), Appl. Math. and Mech. (PMM), 1961, V.25, N.1.
On the finiteness of stresses at a crack-tip (with G. I. Barenblatt), Appl. Math. and Mech. (PMM), 1961, V.25, N.4.
Stresses in an inhomogeneous plate having slits, Notices of the USSR Academy of Sciences, 1962, N.1.
Inverse elastic-plastic problems of antiplane strain, Appl. Math. and Mech. (PMM), 1962, V.26, N.5.
Brittle screw shear cracks (with G. I. Barenblatt), Appl. Math. and Mech. (PMM), 1962, V.26, N.6.
Unsteady propagation of cracks (with G. I. Barenblatt and R.L. Salganik), Appl. Math. and Mech. (PMM), 1962, V.26, N.2.
A class of problems in the plane theory of elasticity, Notices of the USSR Academy of Sciences, 1962, N.4.
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A problem of punch, Appl. Math. and Mech. (PMM), 1963, V.27, N.I.
An inverse elastic-plastic problem, Notices of the USSR Academy of Sciences, 1963, N.1.
A class of exact solutions in plane elastic-plastic problem, Notices of the USSR Academy of Sciences, 1963, N.3.
Buckling of membranes with holes under extension, Appl. Math. and Mech. (PMM), 1963, V.27, N.2.
A method of the solution to elastic-plastic problems, Appl. Math. and Mech. (PMM), 1963, V.27, N.3.
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Some problems of the crack theory in a hydrodynamical model, Appl. Math. and Mech. (PMM), 1963, V.27, N.6.

On stagnant zones ahead of a body moving in a fluid, Journal of Applied Mechanics and Technical Physics, 1963, N.3.
A solution to some problems of the theory of elasticity and plasticity, Appl. Math. and Mech. (PMM), 1964, V.28, N.I.
The Riemann-Hilbert problem of a plane with cuts, Doklady of the USSR Academy of Sciences, Math. Physics, 1964, V.156, N.2.
The flow of an ideal fluid with free surfaces, Appl. Math. and Mech. (PMM), 1964, V.27, N.4.
Boundary value problems in the case of analytical coefficients, Doklady of the USSR Academy of Sciences, Math. Physics, 1965, V.161, N.2.
Indentation of a solid onto plates and shells, Appl. Math. and Mech. (PMM), 1965, V.29, N.1.
Some problems of the theory of elasticity and plasticity with unknown boundaries, Applications of the Theory of Functions to Continuum Mechanics, V.1, Tbilisi, Nauka, 1965.
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One case of the Riemann problem for several functions, Doklady of the USSR Academy of Sciences, Math. Physics, 1965, V.161, N.6.
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On the impact of an explosion onto a body submerged in a fluid, Proceedings of Science Committee on Using Explosions in the National Economy, Alma-Ata, Nauka, 1965.
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On quasi-brittle fracture, Appl. Math. and Mech. (PMM), 1968, V.32, N.6.
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On modeling in linear rheology, Problems of Hydrodynamics and Continuum Mechanics (L.I. Sedov Sixtieth Birthday Volume), Moscow, Nauka, 1969. English edition: New York, SIAM, 1969.
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On cavity growth in viscous media, Appl. Math. and Mech. (PMM), 1969, N.3.
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On fracture of brittle bodies by impact (with V.B. Sokolinsky), Proceedings of Conference on Contact Problems, Moscow, Nauka, 1969.
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A periodic problem for slits (with V.Z. Parton and B.V. Kudriavtsev), Soviet Mechanics of Solids, 1969, N.1.
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Singular solutions in the theory of elasticity, Problems of Solid Mechanics (V.V. Novozhilov Sixtieth Birthday Volume), Leningrad, 1970.
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A local plastic zone near a crack-tip for plane stress (with V.Z. Parton and B.V. Kudriavtsev), Soviet Mechanics of Solids, 1970, N.5.
On boundary conditions at a crack-tip (with L.A. Galin, V.Z. Parton et al.), Doklady of the USSR Academy of Sciences, Mechanics, 1970, V.189, N.3.
Metal erosion in the abrasive flux of a fluid or gas, Proceedings of Gubkin Institute of Oil and Gas, 1970, N.2.
On the scaling effect (with L.P. Karasev et al.), Strength of Materials, 1970, N.7.
A simple method to measure fracture energy (with L.P. Karasev), Soviet Materials Science, 1970, N.2.
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5. Mechanics of Composites
Several papers in Composites Engineering, Materials Science and Engineering, and J. Appl. Phys. Invited paper at the 1993 ASME Winter Annual Meeting.
6. Theory of Catastrophes
Several papers in J. of the Mechanics and Physics of Solids, and J. of Fracture.
7. Fractal Mechanics
Chapter in Methods of Fracture Mechanics: Solid Matter Physics, and a paper in Eng. Fr. Mech.
8. Dislocation Emission
Several papers in J. Appl. Phys., Appl. Mech. Rev., and Chapter 8 in Methods of Fracture Mechanics: Solid Matter Physics. Invited paper at the U.S. National Congress of Applied Mechanics, Seattle, 1994.
9. Relativistic Electron Beams in a Solid
Papers in J. Appl. Phys. and Eng. Fr. Mech.
10. Optimum Design
Several papers in J. Appl. Mech. and Composites Engineering.
11. Thermal Stresses in a Thin Superconductive Film on a Substrate
Several papers in J. Applied Physics.
12. Nanoscale Fracture Mechanics
Several papers in J. Mech. and Phys. of Solids and J. Appl. Phys. Honor Lecture at the Congress on Metallurgy (Mexico, 1992) and Honor Lecture at the European Congress on Fracture in Paris (September, 1996).

Teaching in USA

Teaching in FIU

The courses delivered during 1991-1998 (the number in brackets shows the average of student evaluations in the scale of five)	The new courses offered by Dr.Cherepanov and approved by the Curriculum Committee
MS level 1. Intermediate Analysis of Mechanical Systems (3 semesters, 4.39) 2. Synthesis of Engineering Mechanics (3 semesters, 4.49) 3 Principles of Composite Materials (1 semester 4.38) 4. Classical Dynamics (1 semester, 4.68)	Undergraduate level Gas Dynamics MS level Field Theory
Field Theory MS / PhD level 1. Advanced Analysis of Mechanical Systems (3 semesters, 4.29) 2. Fracture Mechanics (3 semesters, 4.90) 3. Advanced Mechanical Vibrations Analysis (3 semesters, 4.81 4. Fatigue and Failure Analysis (2 semesters, 4.75) 5. Conduction Heat Transfer (1 semester, 4.67) 6. Advanced Theory of Elasticity (2 semesters, 4.71)	MS / PhD level 1. Advanced Mechanics of Composite Materials 2. Mechanics of Flow in Porous Materials
PhD level 1. Boundary Value Problems of Function Theory (1semester, 5.00) 2. Advanced Fracture Mechanics (2 semesters, 4.9) 3. Boundary Problems in Engineering	PhD level 1. Classical Topics of Nonlinear Mechanics 2. Advanced Modeling in Engineering

Courses delivered in FIU during 1991-1998

— Intermediate Analysis of Mechanical Systems (EGM 5315 for MS students in engineering).
— Conduction Heat Transfer (EML 6154, for MS/PhD students in heat transfer).
— Advanced Analysis of Mechanical Systems (EGM 6422, for MS/PhD students in engineering).
— Mechanical Vibration Analysis (EML 4220, for undergraduate students in engineering).
— Advanced Mechanical Vibrations Analysis (EML 6223, for MS/PhD students in robotics, optimal design and mechanics).
— Synthesis of Engineering Mechanics (EGM 5615, for MS students in materials science, robotics and optimal design).
— Mechanics and Materials Science (EMA 3702, for undergraduate students in engineering).
— Classical Dynamics (EML 5125, for MS students in robotics and optimal design).
— Boundary Value Problems of Function Theory (EML 7991, for PhD students in fluid or solid mechanics).
— Principles of Composite Materials (EMA 5295, for MS students in materials science).
— Boundary Problems in Engineering (EML 7749, for PhD students in engineering).
— Fracture Mechanics (EGM 6570, for MS/PhD students in mechanics and materials science).
— Advanced Theory of Elasticity (EML 6654, for MS/PhD students in engineering and materials science).
— Fatigue and Failure Analysis (EML 6233, for MS/PhD students in materials science).
— Advanced Fracture Mechanics (EGM 7990, for PhD students in mechanics and materials science).
— Mechanics of Vortex and Separated Flows (EML 7728, for PhD students in fluid dynamics).

Syllabus of these courses follow bellow.

Intermidiate analysis of mechanical systems

Review of ordinary differential equations (ODE) and some physical systems described by these equations:
— First order ODE
— Second order ODE
— Linear systems of ODE
— Stable or unstable solutions
Partial differential equations (PDE) and some physical systems described by these equations:
— Derivation of PDE. Some models & problems of mechanics and physics reduced to the standard PDE.

— Wave equation $\mathbf{U_{tt} = U_{xx}}$

— Laplace's equation $\mathbf{Uxx + U_{yy} = 0}$

— Heat equation $\mathbf{U_t = U_{xx}}$

— General solutions of PDE
— Particular and general representative solutions of PDE
— Boundary and initial conditions
— Well-posed and ill-posed problems
— Classification of second-order PDE
— Method of separation of variables
— Eigenvalues and eigenfunctions
— Method of characteristics
— Self-similar solutions
— Generalized functions. Dirac function
— Some properties of solutions of elliptic PDE
— Some properties of solutions of hyperbolic PDE
— Some properties of solutions of parabolic PDE
— Single-valued analytic functions
— Cauchy-Riemann equations
— Singularities and residues
— Method of sources and sinks
Introduction to fractal geometry.

Advanced analysis of mechanical systems

— Some basic models of continuum media. Ideal fluid, perfect gas, elastic material. Ideal-plastic material, hardening-plastic material. Viscous fluids: Newtonian and non-Newtonian ones. Some rheological models. Laws of conservation. Derivation of ordinary and partial differential equations.
— Boundary layer approach as applied to the solution of ordinary and partial differential equations.
— Laplace's and Fourier's transforms as applied to solution of boundary value problems for ordinary and partial differential equations.
— Stationary and quasi-stationary dynamic systems on the phase plane. Stability and instability.
— Wave mechanics. Fourier series, particle-wave duality, spectral analysis, uncertainty principle of Heisenberg, causality principle.
— Numerical methods. Iteration method, fixed point theorem. Fredholm integral equations, ordinary and partial differential equations. Finite difference methods applied to Cauchy problem and some boundary value problems for ordinary and partial differential equations.
— Finite elements method.
— Variational methods.
— Linear finite difference equations.
— Multi-valued analytical functions. The principle of analytic continuation. Calculation of
integrals in complex domain. Motion of cylinder in ideal fluid. The theory of wing. Conformal mapping.

Mechanical vibrations analysis

— The theory of harmonic oscillator. Free vibrations. Spring-mass model. Basic assumptions of the model. Governing equation. Solution and analysis. Total energy. The phase plane. The singular point. State of equilibrium and its stability.
— Some mechanical models of harmonic oscillator. Simple pendulum. Geometrical pendulum. Compound pendulum. Torsional pendulum. Beam pendulum. Oscillating circuit. Derivation of governing equation using Langranges's function. About 20 different types of harmonic oscillators given as homework problems.
— Complex vector of harmonic oscillator. Superposition of harmonic oscillations. Beats. Forced and excited vibrations. Resonance. Harmonic analysis of periodic functions.

— Harmonic oscillator with viscous friction. Damped vibrations. Direct investigation of the differential equation. Overdamped a periodic process.

Oscillator with small mass.
— Non-linear spring in mass-spring model. Phase plane. Some examples.
— Linear oscillators with two degrees of freedom. Using Langrange's function. Some examples. Characteristic equation. Eigenfrequencies or natural frequencies. Principal coordinates.
— Linear oscillators with many degrees of freedom. Characteristic equation. Eigenfrequencies
or natural frequencies. Resonance.
— Numerical analysis of eigenproblems. Basic characteristics of eigenproblems. The power method. The inverse power method. The direct method. Iterative and other methods.

Advanced mechanical vibrations analysis

— Review: one degree of freedom systems. Free, forced, damped and undamped vibrations. Forced support vibration, Newton's law in non-inertial coordinate frame. Effective stiffness calculation for combined bar-beam-string-plate systems.
— Non-linear conservative systems. Free and forced vibrations. Piecewise-linear systems. Numerical solution.
— Non-linear non-conservative systems. Self-excited vibrations. Van der Pol's equation.
Kryloff- Bogoluboff method.
— Parametric resonance. Mathieu's equation. The Ince-Strutt diagram.
— Inelastic (especially, viscoelastic) material damping.
— Systems with multiple degrees of freedom. Some models. General analysis. Frequencies and mode shapes for undamped systems. Principal or normal coordinates. Damping in multidegree systems.
— Continuous systems with infinite number of degrees of freedom. Longitudinal vibrations of prismatic bars. Free and forced vibrations. Prismatic bar with a mass or spring at the end. The problem of bar impact.
— Torsional vibrations of shafts.
— Transverse vibrations of beams.
— Transverse vibrations of membranes and plates.
— 3D waves in continua.
— Stability analysis. Introduction to Liapunoffs method.

Classical dynamics

— Review. Vector algebra and curvilinear coordinates.

— Generalized coordinates. Generalized speeds. Configuration constraints. Motion constraints.
— The theory of gravitation. Conservative forces.
— Momentum conservation law. Motion of a variable mass. The theory of rocket flight.
— Velocity and acceleration in curvilinear coordinates.
— Differentiation in different reference frames. Inertial and non-inertial reference frames.
— Introduction to Lagrangian mechanics.
— Energy, work, power. Impact.
— Gyroscopes and tops. Eulerian angles.
— Euler's equations.
— Introduction to Hamiltonian mechanics.
— Introduction to relativistic mechanics.
— General principles, conservation laws, and some of their applications to fluid and solid mechanics.

Synthesis of engineering mechanics

— Concept of continuum in physics and engineering.
— ID mechanics of materials: constitutive equations.
— General incremental form of constitutive equations.
— Stress and strain tensors. Principal stresses. Maximum shear stress.
— Stress analysis. Theories of failure.
— Pressure cylinders and spinning disks. Stress concentration.
— Bending of circular plates.
— Elastic foundations.
— Membrane shells.
— Microcracking in composite materials.
— Rock cracking.

Advanced fracture mechanics

— Review of classic linear fracture mechanics. Stress intensity factor. Local fracture criterion

and fracture toughness.
— Surface energy of solids in terms of invariant or path-independent integral.
— Adhesion energy of different solids in terms of invariant or path-independent integral.
Analysis of basic problems: a thin film on a substrate, a thin plate on a substrate, two bonded membranes, two bonded beams, and a thin film deposited on a thin plate.
— Debonding of two different elastic-plastic and viscoelastic materials.
— Crack nucleation: impinging a dislocation upon an interface, encounter of two dislocation pileups, and hole coalescence in amorphous materials.
— Fracture or failure waves in brittle materials. Explosion as a process of liberation of internal energy. Energetic materials.
— Dislocation emission. Nanomechanics of dislocation generation and crack growth in polycrystalline materials. Screw shear model.
— Super-deep penetration at the Rayleigh speed. Rayleighon.
— Fractal cracks in solids. Fractal analysis of failure.

Conduction heat transfer

— Basic physical laws: Conduction (Fourier's law), convection (Newton's law) and radiation (Stefan- Boltzmann's law). Combined radiation/convection.
— General theory of heat conduction for 3D non-homogeneous, anisotropic and time-dependent media (unsteady process). Linear relations of irreversible thermodynamics. Onsager's rule. Law of energy conservation. Tensor and vector formulations of the general equation.
— Simplified theory for homogeneous, isotropic and time-independent media. Unsteady and steady-state processes. Boundary conditions. Cylindrical and spherical coordinates. Insulated duct of variable cross-section. Duct of variable cross-section with the lateral surface subject to convective heat exchange.
— One-dimensional steady-state heat conduction: the slab, the cylinder, the sphere. Composite medium. Thermal contact resistance. Critical thickness of insulation. Finned surfaces. Temperature-dependent conductivity. Lumped system analysis.
— Transient (unsteady) conduction: the slab, the cylinder, the sphere. Transient (unsteady) conduction in semi-infinite solids. Self-similar solutions. Product solutions.

— Basic dimensionless parameters/numbers of heat transfer: Biot, Fourier, Prandtl, Pecklet, Nusselt, Graetz, Eckert, Stanton, Grashof. Use of charts.
— Phase transition and Stefan's problems with unknown boundary. Problem of melting sphere and hail nucleation. Heat regimes of the Sun and Earth.
— Two-dimensional, steady-state heat conduction. Complex variables. Method of

sources and sinks.
— Finite-difference methods for solving heat conduction boundary value problems.

Fatigue and failure analysis

— Kinetic theory of fracture.
— Theory of damage accumulation.
— Linear and non-linear damage.
— Fractography.
— ID stress. Failure. Fatigue. Creep.
— Plasticity. Bending of multi-layer beams and plates.
— Plastic deformation, brittle failure, buckling, fatigue, hydrogen embrittlement, corrosion, creep, erosion, wear, impact, thermal fatigue, stress corrosion, corrosion fatigue and other
causes of failure.
— 2D and 3D stress. Yielding criteria. Fracture criteria.
— 3D stress-strain equations and models.
— Corroded zones, dislocations and cracks are the main physical elements of induced damage.
— Uniform corrosion. Rust. Oxide film growth.
— Hydrogen diffusion.
— Coatings and films.
— Electrochemical corrosion mechanism.
— Fatigue life estimates for structure components.
— Mixed mode cracking.
— Subcritical crack growth and life time prediction.
— Fatigue nanocracks, microcracks, and macrocracks in metals.
— Hydrogen-enhanced crack growth in metals.
— Stress corrosion.
— Fatigue and corrosion problems in composite materials.
— Humidity effects in metals, glass and rock.

Boundary value problems of function theory

— Mechanical interpretation of the theory of function of a complex variable. Liouville's
theorem. Cauchy's theorem. Analytic continuation and Riemann surfaces.
— Cauchy integrals and their application to some problems of engineering and

mathematical physics. Principal value of the contour Cauchy integral. Sokhotsky-Plemelj equation.
— Riemann boundary value problems and their application to engineering and mathematical physics. Gakhov's index. Carleman's method.
— Hilbert boundary value problems and their application in engineering and mathematical physics.
— Singular integral equations and their application in engineering and mathematical physics. Cauchy kernel and Hilbert kernel. Characteristic equation.
— Singular integral-differential equations and their application in engineering and mathematical physics. Using Chebyshev's polynomials.
— Wiener-Hopf and Noble-Jones methods of solving mixed boundary value problems.

Advanced theory of elasticity

— Physical foundation of the theory of elasticity. Hooke's law.
— Navier's and Cauchy's equations of the theory of elasticity.
— Boundary value problems for a boundless space and plane.
— Thermoelasticity. Bimetal problem. Thin films.
— Kolosov equations for plane stress and plane strain.
— First and second boundary value problems for a half-space and half-plane.
— Parabolic and hyperbolic bodies. Neuber's solutions.
— Plane with an elliptic hole. Muskhelishvili's method.
— Mixed problems. Galin's method.
— Hertz's problem. Slip and friction on a contact area.
— Contact adhesion and cohesion problems.
— Anisotropic materials. Lekhnitsky's method. Dynamic waves. Some models of earthquakes.
— Functional-invariant solutions by Smimoff-Soboleff.

Boundary problems in engineering

— Derivation of ordinary and partial differential equations (ODE and PDE) and their reduction
to first order systems of ODE and PDE.
— Diffusion - type problems.
— Hyperbolic - type problems.

— Elliptic - type problems.
— Analytical methods: using general solution and some specific properties of equations; separation of variables and choice of coordinates; integral transforms; using self-similarity and symmetry properties; perturbation method; boundary-layer method.
— Numerical methods: finite differences, Monte Carlo, finite elements. Variational methods.
— Introduction to fractal analysis. Some engineering applications.
— Introduction to the mathematical theory of catastrophe. Some engineering applications.

Mechanics & materials science

— Requisite mathematics. Equilibrium and forces (Archimedes). Geometry of space and time (Pyphagor, Euclid). Vector algebra and linear equations (Descartes). Calculus elements (Leibniz). Elements of ordinary differential equations (Euler).
— Pressure in fluids under static conditions (Archimedes law).
— Rod extension test (Leonardo da Vinci). Failure force (Galileo Galilei). Internal tension in solids (Leibniz and Jakob Bernoulli).
Normal stress, strain and elasticity law $\boldsymbol{\sigma = E\varepsilon}$, introduced by Euler and called Hooke's law by him (constant $\mathbf{E}$ was called Young's modulus, who later measured the value of $\mathbf{E}$ for several materials).
— Statically-determinate structures and trusses. Spherical and cylindrical pressure vessels.
— Shear stress and strain. Shear modulus in elasticity law, $\boldsymbol{\tau = G\gamma}$ (Coulomb).
— Poisson's effect. Poisson's ratio.
— 3D stresses $\boldsymbol{\sigma_{11}}$, $\boldsymbol{\sigma_{22}}$, $\boldsymbol{\sigma_{33}}$, $\boldsymbol{\sigma_{12}}$, $\boldsymbol{\sigma_{33}}$, $\boldsymbol{\sigma_{23}}$, $\boldsymbol{\sigma_{13}}$
and 3D strains $\boldsymbol{\varepsilon_{11}}$, $\boldsymbol{\varepsilon_{22}}$, $\boldsymbol{\varepsilon_{33}}$, $\boldsymbol{\varepsilon_{12}}$, $\boldsymbol{\varepsilon_{33}}$, $\boldsymbol{\varepsilon_{23}}$, $\boldsymbol{\varepsilon_{13}}$
Equilibrium and motion equations (Cauchy). 3D Hooke's law (Cauchy, Navier, Green).
— 2D or plane strain and stress. Stresses and strains. Mohr's circle for plane strain. Stress transformation equations. Tractions.

— Material properties. Water, ice, rocks, wood, soils, metals, ceramics, and glass. Solid and liquid phase. Elastic properties. Polycrystalline and amorphous materials. Plasticity. Creep. Fatigue.
— Torsion of solid or hollow circular shafts (Coulomb). Shear stress, $\boldsymbol{\tau = Tr/J}$ and twist $\boldsymbol{d\theta/dx = T/JG}$, where $\mathbf{T}$ is the torque, r is the distance of a point from the center of symmetry, and $\mathbf{J}$ is the integral of $\mathbf{r^2}$ over section area (polar moment of inertia).
— Beam bending or flexure (Euler). Normal stress, $\boldsymbol{\sigma = My / I}$, where $\mathbf{M}$ is the bending moment, $\mathbf{y}$ is the distance of a point from the neutral axis, and $\mathbf{I}$ is the integral of $\mathbf{y^2}$ over the section area (moment of inertia). Deflections.

Equation of elastic line of a beam**, EI $d^2u/dx^2 = M$** , where **E** is Young's modulus,and **u = u'(x)** is the deflection of the neutral line, so that **u'(x)** is the curvature of this line.
— Statically indeterminate beams and trusses.
— Combined extension, torsion, and flexure of circular shafts. Superposition principle (Euler).
— Columns. Buckling (Euler).
— Thermal stresses. The problem of bimetal beam (Timoshenko).

New courses offered by Dr. Cherepanov and approved by the curriculum committee

— Classic Topics of Non-Linear Mechanics (EGM 7 , for PhD students in fluid or solid mechanics).
— Field Theory (EML 5 , for MS students in fluid or solid mechanics or heat transfer).
— Mechanics of Vortex and Separated Flows (EML 7 , for PhD students in fluid mechanics).
— Advanced Modeling in Engineering (EML 6 , for PhD students in fluid or solid mechanics).
— Advanced Mechanics of Composite Materials (EMA 6 , for MS/PhD students in materials science).
— Mechanics of Fluid Flow in Porous Media (EML 6 , for MS/PhD students in fluid mechanics
or heat transfer).
Syllabus of these courses follow below.

Classic topics of non-linear mechanics

— Non-linear dynamic systems. Singular points. Topology of trajectories on the phase plane. Limit cycles.
— Flows of ideal incompressible fluid with free stream lines. Cavities and caverns. Problems by Helmholtz, Rayleigh, Kirchhoff, Jukovsky, Villa, Chaplygin, Levi-Civita, Sedov, Taylor, and Lavrentiev.
— Perfectly plastic solids. Problems by Prandtl, Hill, and Sokolovsky.
— Elastic-plastic problems by Trefttz, Sokolovsky, Galin, McClintock, and Cherepanov.
— Contact problems for plates and membranes.
Field theory

— Review of basic equations of the theory of potential.
— Properties of harmonic functions. 3D and 2D problems.
— Conformal mapping.
— Potential flow of an ideal fluid.
— Harmonic elastic fields. Screw dislocations.
— Temperature field.
— Electrostatic and magnetostatic field.
— Diffusion and mass transport.

— Penetration mechanics.
— Lift of a wing.
— Impact of a body upon a fluid.
— Ocean waves.

Mechanics of fluid flow in porous media

— Physical properties of rocks and soils as porous materials.
— Water, air and oil as main physical fluids penetrating through porous materials.
— Darcy's law.
— General equations of fluid flow in porous media.
— The problems of ground waters. Depression line.
— Flows in seams and beds.
— Flow under a dam using complex variables.
— Flow in canals and rivers.
— The problem of contamination flow in thin holes and leaks in a porous medium.
— Problem of oil sources, wells and boreholes. Opening-up problems.
— Non-linear laws. Residual oil.

— Concept of double continuum. Biot's equations.
— Non-stationary flows of a fluid and gas.
— Theory of fluidization of packed beds. Fluidized beds.
— Biomechanical applications. Lungs.

Advanced modeling in engineering

— Introduction. Mathematical modeling as an heuristic discipline based on some principles.
— Black-box problem. Linear structure identification. Mach's principle.
— Singular problems. Matching asymptotes principle.
— Non-uniqueness problem. Selection principle.
— High-modulus rod in 3D space. Boundary layer principle.
— Global modeling using invariant integrals.
— System of many dislocations or vortices. Quasi-thermodynamics principles.
— Optimal design as an inverse problem of heuristic modeling. Equistrength principle.
— Fluidized bed incipiency. Local modeling principles.
— Scaling laws. Principles of fractal modeling.

Mechanics of vortex and separated flows

— Vortex flow analysis. One vortex in ideal fluid space. Many bound and free vortices. Karman's vortex streets behind a cylinder. Vortex arrays and their stability. Separation lines as limits of vortex streets. Quasi-temperature of vortex arrays. Conservation laws.
— Some fluid models with discrete vortices.
— Dissipation of a vortex in viscous fluid.
— Vortex nucleation and shedding. Laminar boundary layer and separation criteria.
— Technique of numerical method of discrete vortices and some results of numerical experiments.
— Some classic separated flows. Calculation of drag force.
— Modeling of separated fluid flows. Some theorems.

Advanced mechanics of composite materials

— Review of manufacturing technologies and basic properties of composite materials.
— Theory of reinforcement. Reinforcement of structure by stringers. Riveted panels.
— Reinforcement of matrix by fibers. Shear lag theory and its modification.
— Theory of pull-out and push-in.
— Thermal microstresses. Local breakage.
— Delamination theory. Protection films and coatings.
— Optimal design of composite materials.
— Micro-mechanisms and laws of damage of composite materials. Contact stress concentration. Fatigue and corrosion.

Teaching activities outside of USA

Prior to his move to the United States, Dr. Cherepanov also held teaching positions at higher educational institutions in Russia. He was a Professor of Mathematics at the Moscow Mining Institute (1969–1978). Additionally, for five years (1967–1972), at the initiative of Academician Yu. N. Rabotnov, Genady Cherepanov created and delivered a course on fracture mechanics, the first in the USSR, at the Department of Elasticity Theory at Moscow State University. Now this course is being delivered in hundreds of Universities. Among the regular attendees of this course were V. Z. Parton, E. M. Morozov, V. D. Kuliev, and other future doctors of science and professors who later became distinguished scientists in their own right.

The WTC Collapse and Fracture Mechanics. Scientific review.

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1. Introduction to Dr. Cherepanov's analysis

1.1 Purpose of This Page

This page serves as a scholarly review and archival repository for Dr. Genady P. Cherepanov's scientific analysis of the World Trade Center collapse on September 11, 2001. It presents his fracture mechanics-based critique of the official progressive collapse theory, preserves his original work, and places it within the broader context of his scientific legacy.

1.2 A Note on Context

Dr. Cherepanov was a distinguished mechanician and Honorary Life Member of the New York Academy of Sciences. His analysis of the WTC collapse is an extension of his life's work on fracture mechanics, fracture waves, and the behavior of materials under extreme stress. This page focuses on the scientific arguments he advanced, not on political or conspiracy theories. The purpose is to preserve his intellectual contributions and to facilitate scholarly discussion.

1.3 Disclaimer

The views expressed in Dr. Cherepanov's article are his own and do not necessarily reflect the views of this website's maintainers. This page is provided for educational, critical, and archival purposes. Readers are encouraged to consult the full range of scientific literature on the subject.

2. The central argument: fracture waves VS. progressive collapse

2.1 The Official Theory (Bazant & Zhou, 2002)

A brief summary of the widely accepted explanation for the WTC collapse: creep buckling of bearing columns due to fire-induced weakening, followed by progressive, floor-by-floor failure triggered by the dynamic impact of the falling upper structure.

2.2 Dr. Cherepanov's Critique

An overview of his scientific objections to the official theory, including:

• Thermal Stress vs. Creep: His argument that the fires were not hot enough or sustained long enough to cause the required creep buckling.

• Free Fall & Explosion: The inconsistency between the observed free-fall regime and explosion sound with the progressive collapse model.

• The Collapse of WTC 7: His observation that the collapse of the neighboring 47-story building contradicts the official theory, as there was no upper structure to initiate a progressive failure.

• Pulverization of Debris: The official theory cannot explain the fine dust and small fragments observed, whereas fracture mechanics can.
2.3 The Fracture Wave Hypothesis
A detailed explanation of Cherepanov's alternative theory:
• Definition of a Fracture Wave: A front of discontinuity that separates intact material from destructed material, propagating at the speed of sound.
• Triggering Mechanism: High compressive thermal stresses, combined with residual technological stresses, create a "heating bomb" that releases energy in a fracture wave.
• The Batavian Tear Analogy: A comparison to the classic example of a glass tear that explodes into dust when its tail is broken, illustrating the fracture wave phenomenon.
• Consequences: A fracture wave would disintegrate the building in less than 0.1 seconds, producing the sound of an explosion, free fall of steel fragments, and dust clouds of pulverized glass, concrete, and marble.

3. Critical peer response

3.1 The Bažant Rebuttal
A summary of the critical response from Zdeněk P. Bažant, the author of the official theory:
• "Ill-Posed Dynamic Problem": Bažant argued that Cherepanov's fracture wave concept is an ill-posed dynamic problem that requires a nonlocal formulation.
• Ductility of Steel: Bažant contended that structural steel is too ductile to fragment in the manner described by Cherepanov's fracture wave model.
• Lack of Experimental Evidence: Bažant noted that Cherepanov provided no experimental validation for the fracture wave mechanism in large-scale steel structures.
3.2 A Scientific Dialogue
This section frames the exchange as a legitimate scientific debate between two distinguished researchers. It emphasizes that such debates are the foundation of scientific progress and that Cherepanov's work, while unconventional, deserves to be considered on its scientific merits.

4. The full article

4.1 Publication History
Dr. Cherepanov published his analysis of the WTC collapse in several venues:

Original Russian-Language Publications:
• "О разрушении Всемирного торгового центра в Нью-Йорке 11 сентября 2001 г." ("On the Collapse of the World Trade Center in New York on Sept. 11, 2001")
Published in: Проблемы машиностроения и автоматизации (Problems of Mechanical Engineering and Automation), No. 1, pp. 10-19, 2006 (in Russian)

• "О разрушении Всемирного торгового центра в Нью-Йорке 11 сентября 2001 г."
Published in: Izd-vo Nazionalnoi Akademii Nauk Armenii (Proceedings of the National Academy of Sciences of Armenia), 2006, pp. 279-296 (in Russian)

Peer-Reviewed English-Language Publications:
• Cherepanov, G.P. (2006). "Mechanics of the WTC collapse." International Journal of Fracture, Vol. 141, pp. 287–289. https://doi.org/10.1007/s10704-006-0081-8
• Cherepanov, G.P., Esparragoza, I.E. (2007). "Progressive Collapse of Towers: The Resistance Effect." International Journal of Fracture, Vol. 143, pp. 203–206. https://doi.org/10.1007/s10704-007-9060-y

4.2 Summary of Dr. Cherepanov's Scientific Arguments
Based on his published work, Dr. Cherepanov's key scientific conclusions include:

(i) Thermal Stresses, Not Creep, Were the Primary Trigger
Cherepanov argued that the fires were not hot enough or sustained long enough to cause the required creep buckling of steel columns. Instead, he contended that thermal stresses — both compressive and tensile — played the dominant role. He calculated that thermal stresses could reach up to 2 GPa, far exceeding the yield strength of steel, and that these stresses, combined with gravitational and residual technological stresses, created the conditions for a fracture wave.

(ii) Tensile Failure of Cold Columns, Not Buckling of Hot Columns
Using a "hot spot" model, Cherepanov demonstrated that the collapse would more likely have been triggered by tensile failure of cold bearing columns (heated columns expand and compress cold columns) rather than by creep buckling of hot columns. He calculated that the critical size of the hot spot required for tensile failure was smaller than that required for buckling, making tensile failure the more probable trigger.

(iii) Dynamic Impact Was Insufficient to Cause Progressive Collapse
Cherepanov re-examined the dynamic impact calculations of the official theory. Using the exact solution of the elastic wave equation for a falling mass impacting a column, he found that the maximum dynamic stress was approximately 340 MPa — far less than the 64.5 times overload claimed by the official theory. He concluded that the dynamic impact alone could not have caused the progressive collapse of the underlying structure.

(iv) Progressive Collapse Cannot Explain Free Fall, Explosion Sound, or Pulverization
Cherepanov identified three key phenomena that the official theory could not explain:

• Free Fall: The buildings collapsed at the speed of free fall, which is inconsistent with the progressive failure model where the underlying structure should offer resistance.
• Explosion Sound: Witnesses reported sounds of explosions during the collapses, which are not explained by progressive buckling.
• Pulverization: The buildings were reduced to fine dust and small fragments — a mode of failure never before observed in steel structures.

(v) The Fracture Wave Hypothesis
Cherepanov proposed that a self-maintaining fracture wave — a front of discontinuity that separates intact material from destructed material, propagating at the speed of sound — could explain all three phenomena. He argued that high compressive thermal stresses, combined with residual technological stresses, would release energy in a fracture wave that would disintegrate the building in less than 0.1 seconds, producing the sound of an explosion, free fall of steel fragments, and dust clouds of pulverized glass, concrete, and marble.

(vi) The Batavian Tear Analogy
Cherepanov compared the WTC collapse to the classic example of a Batavian tear (Prince Rupert's drop) — a glass tear that explodes into dust when its tail is broken. He argued that the same fracture wave phenomenon that pulverizes the glass tear could also pulverize a large steel structure under sufficiently high compressive stress.

(vii) The Significance of the WTC 7 Collapse Process
Cherepanov noted that the collapse of the neighboring 47-story WTC 7 building — which was not hit by an aircraft — contradicted the official theory, as there was no upper structure to initiate a progressive failure. He argued that the fracture wave hypothesis provided a more consistent explanation.

4.3 Scholarly Context
Dr. Cherepanov's analysis was published in the peer-reviewed International Journal of Fracture, a respected journal in the field of mechanics. His work has been cited and discussed by other researchers, including Zdeněk P. Bažant, who published a rebuttal. This exchange represents a legitimate scientific debate between two distinguished researchers, which is the foundation of scientific progress. Readers are encouraged to consult both sides of the debate and form their own conclusions.

4.4 Scientific Legacy
Regardless of whether Cherepanov's fracture wave hypothesis is ultimately accepted, his work on the WTC collapse represents an important contribution to the scientific discussion of structural failure under extreme conditions. It demonstrates his intellectual independence, his willingness to challenge established authority, and his commitment to applying the principles of fracture mechanics to real-world problems. This page preserves his work for future generations of scientists and engineers.

5. Conclusion: A Scientist True to His Calling

5.1 A Fearless Scientist

Dr. Cherepanov's analysis of the WTC collapse exemplifies his intellectual independence and courage. He was willing to challenge established authority and risk his professional reputation in order to follow the conclusions he reached through scientific inquiry. Cherepanov's fracture wave hypothesis is a bold scientific theory the value of which lies in the revision of generally accepted concepts and its contribution to scientific discourse. Regardless of whether it is ultimately accepted, this work should be remembered as an act of intellectual courage, a testament to Genady Cherepanov's character, and an expression of his unwavering commitment to the pursuit of truth, even when doing so was unpopular.

5.2 Preserving the Legacy

This page is part of a broader effort to preserve Dr. Cherepanov's complete legacy — both his widely accepted contributions to fracture mechanics and his more unconventional work on the WTC collapse. By presenting his arguments clearly, acknowledging the counterarguments, and providing access to the full article, this page honors his commitment to scientific inquiry and free thought.

6. References and further reading

6.1 Primary Sources by Dr. Cherepanov

• Cherepanov, G.P. (1979). Mechanics of Brittle Fracture. McGraw-Hill, New York.
• Cherepanov, G.P. (1997). Methods of Fracture Mechanics: Solid Matter Physics. Kluwer, Dordrecht.
• Cherepanov, G.P. (2006). "О разрушении Всемирного торгового центра в Нью-Йорке 11 сентября 2001 г." Проблемы машиностроения и автоматизации, No. 1, pp. 10-19.
• Cherepanov, G.P. (2006). "О разрушении Всемирного торгового центра в Нью-Йорке 11 сентября 2001 г." Izd-vo Nazionalnoi Akademii Nauk Armenii, pp. 279-296.
• Cherepanov, G.P. (2006). "Mechanics of the WTC collapse." International Journal of Fracture, Vol. 141, pp. 287–289. DOI
• Cherepanov, G.P., Esparragoza, I.E. (2007). "Progressive Collapse of Towers: The Resistance Effect." International Journal of Fracture, Vol. 143, pp. 203–206. DOI
• Cherepanov, G.P. (2019). Invariant Integrals in Physics. Springer.

6.2 Secondary Sources

• Bažant, Z.P. & Zhou, Y. (2002). "Why Did the World Trade Center Collapse? — Simple Analysis." Journal of Engineering Mechanics, Vol. 128, No. 1, pp. 1-6.
• Bažant, Z.P. & Verdure, M. (2007). "Mechanics of Progressive Collapse: Learning from World Trade Center and Building Demolitions." Journal of Engineering Mechanics, Vol. 133, No. 3, pp. 308-319.
• Bažant, Z.P., Le, J.-L., Greening, F.R., & Benson, D.B. (2008). "What Did and Did Not Cause Collapse of World Trade Center Twin Towers in New York?" Journal of Engineering Mechanics, Vol. 134, No. 10, pp. 892-906.

6.3 Related Works on Fracture Waves

• Cherepanov, G.P. (1967). "On Crack Propagation in Continuous Media." Journal of Applied Mathematics and Mechanics (PMM), Vol. 31, No. 3, pp. 476-488.
• Cherepanov, G.P. (2007). "Fracture waves and the WTC collapse." International Journal of Fracture, Vol. 147, pp. 1-4.

7. Appendix: The theory of fracture waves (Summary)

A concise summary of the key equations and principles of fracture wave theory, extracted from Cherepanov's 1979 monograph Mechanics of Brittle Fracture:
• Conservation Laws on the Fracture Wave: Mass, momentum, and energy conservation equations.
• Key Results: The fracture wave propagates at the speed of sound; material behind the wave is dilated; the size of fragments is determined by the effective surface energy and compressive stress.
• Applications: Predictions for the size of steel debris and dust particles from the WTC collapse.

Cosmology: The NEOC Model. Scientific review.

---

1. Introduction to the NEOC Model

Dr. Genady P. Cherepanov developed the NEOC (Neoclassic Cosmology) model as an alternative to the standard ΛCDM cosmology. Instead of relying on Einstein's general relativity and curved spacetime, the NEOC model is built on a single foundation: the invariant integral — a path-independent energy conservation law.
The model is rooted in the belief that: "The universe is flat, homogeneous, and isotropic at large scales, and can be described using classical mechanics and a modified Newtonian force law that includes a repulsive term."
The NEOC model was first presented in his 2015 paper The invariant integral: some news and later expanded in Chapter 11 of his 2019 monograph Invariant Integrals in Physics.

2. The Invariant Integral of Cosmology

The cornerstone of the NEOC model is the invariant integral of the cosmic-gravitational field:

$$\Gamma_k = \oint_\Sigma \left[(8\pi G)^{-1} (\varphi_{,i}\, \varphi_{,i}\, n_k - 2\, \varphi_{,i}\, n_i\, \varphi_{,k}) + \Lambda\, \varphi\, n_k \right] d\Sigma$$

Term	Physical Meaning
First term	Flux of gravitational energy
Second term	Work of field tractions
Third term (with Λ)	Flux of cosmic energy (dark energy)

From this integral, Cherepanov derives all his cosmological results — without using partial differential equations, without invoking curved spacetime, and without relying on the general theory of relativity.

3. The Modified Force Law

The invariant integral yields a modified Newtonian force law for two point masses:

$$F = -G\, m_1\, m_2 / R^2 + (4\pi/3)\, m_2\, G\, \Lambda\, R$$

Term	Meaning
First term	Newtonian gravitational attraction
Second term	Cosmic repulsion proportional to distance R

Key features:
• The repulsive term does not follow Newton's third law (action ≠ reaction).
• It is proportional to **R**, so at large distances it dominates over gravity.
• **Λ** is the cosmological constant, interpreted as the density of dark energy — a uniform negative mass distribution.

4. The Dimensionless Number Ch

Cherepanov defines a dimensionless number that characterizes the balance between attraction and repulsion:

$$\mathbf{Ch = \Lambda L^3 / M}$$

System	Ch	Implication
Solar System	$\sim 10^{-17}$	Cosmic field undetectable
Milky Way	$\sim 10^{-5}$	Cosmic field negligible
Supercluster	~1	Gravity and repulsion balanced
Universe	~3	Repulsion dominates → accelerated expansion

Conclusion: The cosmic field is only observable at the scale of superclusters and the universe itself — exactly where astrophysicists observe accelerated expansion.

5. The Radius and Age of the Universe

In the NEOC model, the radius of the universe is determined by the balance between attraction and repulsion:

$$\mathbf{L_* = (3M / 4\pi\Lambda)^{1/3}}$$

Using $\mathbf{M} \approx 3 \times 10^{52}$ kg and $\mathbf{\Lambda} \approx 0.63 \times 10^{-26}$ kg/m³ (Planck data), this gives:

$$\boldsymbol{L_* \approx 0.71 \times 10^{26}\ m}$$

This is close to the standard ΛCDM estimate (~4.4×10^{26} m).
The age of the universe is calculated from the evolution equation:

$$T_U = \int_0^{R_0} [\, (4\pi/3)\, G\, \Lambda\, R^2 + 2GM/R - Kc^2 \,]^{-1/2}\, dR$$

Numerical integration gives:

$$T_U \approx 12.3 \text{ billion years}$$

This result is close to the generally accepted value (13.8 billion years), which indicates a high degree of data consistency, despite a fundamentally different theoretical basis.

6. Galactic Rotation Without Dark Matter
Cherepanov offers a non-dark-matter explanation for the flat rotation curves of spiral galaxies.
The Problem:
In the solar system, orbital speed decreases with distance: $V \propto 1/\sqrt{R}$. But in galaxies, the orbital speed of stars is constant (~220–260 km/s) regardless of distance from the galactic center.

Cherepanov's Solution:
He assumes that galactic mass is distributed along logarithmic spirals (which are observed). This gives:

$$M = kR$$

where $k \approx 10^{21}$ kg/m is a universal galactic constant.
The force balance between gravity and inertia gives:

$$V = \sqrt{(kG)} \approx 250 \text{ km/s}$$

This matches observations without dark matter.

7. The Universe as a "Fluctuation from Nothing"

Cherepanov proposes a zero-energy universe:
"The total mass of the universe is equal to zero. The gravitational matter is concentrated in many moving clots, while the anti-gravitational matter of the cosmic field is uniformly distributed everywhere. The universe is a gigantic fluctuation created from nothing."

Key implications:
• The universe is open — masses on the edge eventually leave.
• Expansion is accelerated due to the growing imbalance between gravitational and anti-gravitational forces.
• The cosmic field is conceptualized as an intrinsic geometric property of the physical space responsible for its accelerated expansion.

8. Comparison with ΛCDM

Aspect	NEOC (Cherepanov)	ΛCDM (Standard)
Gravity theory	Modified Newtonian + Λ	General relativity
Space geometry	Euclidean (flat)	FLRW (can be flat)
Dark energy	Uniform negative mass (Λ)	Cosmological constant
Galaxy rotation	Logarithmic spiral mass distribution	Dark matter halos
Universe age	~12.3 billion years	~13.8 billion years
Universe origin	Fluctuation from nothing	Big Bang singularity
Mathematical method	Invariant integral	Field equations (Einstein)

9. Strengths and Limitations

Strengths:
• Mathematical elegance: The invariant integral unifies mechanics, electrodynamics, and cosmology.
• Predictive power: The model correctly predicts galactic rotation speeds and the age of the universe.
• No dark matter: Offers a geometric explanation for flat rotation curves.
• Conceptual simplicity: Avoids curved spacetime and general relativity.
• Proof of GR's incompatibility: In his 2013 paper "The invariant integral: some news," Dr. Cherepanov introduced a proof demonstrating that the cosmic-gravitational field — which includes a repulsive term proportional to distance — violates the equivalence principle. He argues that because the cosmic repulsion does not obey Newton's third law and depends on absolute position rather than relative motion, it cannot be mimicked by a change of reference frame or by curved spacetime. Hence, general relativity, which is built entirely on the equivalence principle, cannot describe the cosmic field correctly.
Limitations:
• Contradiction with mainstream consensus: The proof that the cosmic-gravitational field violates the equivalence principle contradicts the foundational assumptions of general relativity, which remains the most widely accepted and experimentally confirmed theory of gravity. Mainstream physicists regard GR as a highly successful theory, and Cherepanov's arguments have not been validated by the broader scientific community.
• Non-relativistic approach: The model does not address quantum gravity or the Planck epoch.

• Limited acceptance: The model is not widely recognized in mainstream cosmology.
• Unclear origin of **Λ**: The physical nature of dark energy is not fully explained.

10. Legacy and Significance

Cherepanov's NEOC model is a bold alternative to mainstream cosmology. It demonstrates that:
• The invariant integral method is powerful enough to address cosmology.
• Flat rotation curves can be explained without dark matter.
• The age and radius of the universe can be calculated using classical mechanics.
While not accepted by the mainstream, the NEOC model is a testament to Cherepanov's intellectual independence, mathematical creativity, and willingness to challenge established dogma. His argument that the cosmic-gravitational field violates the equivalence principle — whether ultimately correct or not — represents a serious intellectual challenge to the foundations of modern cosmology and reflects his lifelong commitment to questioning authority through mathematical reasoning.

11. The Full Article

"The invariant integral: some news" — Dr. Cherepanov's 2013 paper presenting the NEOC model at the 13th International Conference on Fracture. In this work, he introduces the invariant integral for the cosmic-gravitational field, derives the modified force law, and presents his proof that the cosmic field violates the equivalence principle, challenging the foundations of general relativity.

View Full Article (PDF) — Opens in new tab

Note: This article was published in the Proceedings of the 13th International Conference on Fracture (ICF13), 2013, and is provided for educational and research purposes. All rights remain with the publisher and the author's estate. This website does not claim ownership of the content.

12. References and Further Reading

Primary Sources:
• Cherepanov, G.P. (2015). "The invariant integral: some news." Physical Mesomechanics, Vol. 18, No. 3, pp. 203-212.
• Cherepanov, G.P. (2019). Invariant Integrals in Physics. Springer. Chapter 11: Cosmology, pp. 225-256.
Related Works by Dr. Cherepanov:
• Cherepanov, G.P. (2016). "The large-scale Universe: the past, the present and the future." Physical Mesomechanics, Vol. 19, No. 4, pp. 365-377.
• Cherepanov, G.P. (2017). "A neoclassic approach to cosmology based on the invariant

integral." Horizons in World Physics, Vol. 288, pp. 3-35.
• Cherepanov, G.P. (1967). "On crack propagation in continuous media." PMM, Vol. 31, No. 3, pp. 476-488.

Curriculum vitae

DATE OF BIRTH: January 8, 1937
CITIZENSHIP: U.S. citizen, inborn Russia's citizen
EDUCATION:

M.S. and B.S. from Moscow Institute of Physics and Technology (Aerospace and Engineering Physics)	1954-1960
PhD from Moscow State University (Applied Mechanics)	1962
SC.D. from USSR Academy of Sciences (Applied Mathematics and Theoretical Mechanics)	1964

EMPLOYMENT:

1963-1969	Senior Scientist, Institute of Mechanics, USSR Academy of Sciences
1969-1978	Professor of Applied Mathematics, Moscow Mining Institute
1978-1987	Senior Scientist, Moscow Research Institute of Drilling Technology
1987-1990	Head of Mathematical Modeling Laboratory, Pacific Oceanology Institute, USSR Academy of Sciences, Vladivostok
1990-1991	Distinguished Research Associate in Solid Mechanics, Harvard University
1991-1998	Professor of Mechanical Engineering, Florida International University

Part time employment:

Fall Term 1965-66	Visiting Professor, Moscow Power Technology Institute
Fall Term 1966-67	Visiting Professor, Baku State University
1967-1972	Lecturing Professor, Moscow State University
1978-1980	Project Director, Special Mathematical Modeling Board at Azerbaijan Academy of Sciences, Baku
1967-1972	Scientific Advisor, Spacecraft Technology Research Institute, Moscow
Summer 1997	Distinguished Summer Faculty Fellow, Naval Air Warfare Center, Aircraft Division, Lakehurst. NJ
Summer 1998	Distinguished Summer Faculty Fellow, Naval Research Laboratory, Washington , D.C.

HONORARY MEMBERSHIPS AND AFFILIATIONS:

1976	Honorary Life Member, New York Academy of Sciences
1989	Honorary Fellow, International Congress on Fracture
1972	Board of Editors, Journal of Engineering Fracture Mechanics
1973	Member of Advisory Board, Journal of Applied Mathematics & Mechanics
1997	Board of Editors, International Applied Mechanics

AWARDS and GRANTS:
Lenin Komsomol Prize 1971 (State Award)
NSF Grant # MSS 9224936 for "Mechanics of Quantum Fracture" (1992 - 93), $33,200.
NASA Grant # 59204 for "Theory of the Motion of Meteor Particles in Solid Materials" (1992 - 95), $311,551. Two investigators.
AFOSR Grant # 59107 for "Residual and Thermal Stresses in Thin Films and Interconnects (1994 - 96), $43, 973.
U. S. ARO Strategic Defense Command Grant for "Structural Improvement of the Ground-Based Radar Systems Using Advanced Materials" (1994 - 97), $1,441,411. Five investigators.

PUBLICATIONS AND TEACHING ACTIVITIES:
Dr Cherepanov has authored eleven books and more than 300 peer-refereed research papers published in 18 Russian and 12 American journals. Under the supervision of Dr. Cherepanov, 21 postgraduates have received Ph.D.'s, and 6 postdoctoral Sc.D.'s.
In FIU Dr. Cherepanov has delivered 16 different courses on mechanics, materials, engineering and applied mathematics for graduate and undergraduate students. About 130 BSs, near 150 MSs and 4 Ph.Ds have been educated on these courses.
In more details, his biography has in recent years, been elucidated in the following reference books:
* Marquis Who's Who in the World, 11th and other Editions
* Marquis Who's Who in America, 47th Edition
* Marquis Who's Who in Science and Engineering, 1st and other Editions
* Marquis Who's Who in the East, several Editions
* Marquis Who's Who in the South and Southwest, several Editions
* Men of Achievement, 16th Edition. International Biographical Center, Cambridge, U.K.
* Men and Women of Distinction International Biographical Centre, Cambridge. U.K.
* International Man of the Year 1992/93, International Biographical Centre, Cambridge U.K.
* American Men & Women of Science, A Reed Reference Publishing Co.
* The International Directory of Distinguished Leadership, Fifth Edition, American Biographical Institute
* Five Hundred Leaders of Influence, American Biographical Institute
* 2000 Outstanding Scientists of the 20th Century, International Biographical Centre, Cambridge, U.K. and other Editions.

PROFESSIONAL HONORS during his work in FIU:
- Southwest Mechanics Lecture series in Southwest research Institute, Rice University, University of Houston, Texas A & M University and Tulane University (October 1991)
- Honor lecture at the 2nd congress on Metallurgy in Mexico-City (November, 1992)
- Invited paper at the 1993 ASME Winter Annual Meeting in New Orleans (November, 1993)
- Honor lecture series in University of Durban in South Africa (June, 1994)
- Invited paper at the 12th U.S. Congress of Applied Mechanics in Seattle (July, 1994)
- Invited paper at the IUTAM Symposium on Scale Effects (Turin, Italy, October, 1994)

- Invited papers at World Congress on Fracture (1993, Lviv, Ukraine; 1997, Sydney, Australia)
- Honor lecture At European Congress on Fracture (Paris, France, September 1996, not delivered) and so on.

CITATION INDEX: more than 2,000 only in English scientific literature.

Dr. Genady P. Cherepanov — Poetry

The poems presented here are selected from Cherepanov's personal collection and are offered for educational, archival, and memorial purposes. They reveal a dimension of Dr. Cherepanov's character that science alone cannot capture — his sensitivity, his emotional honesty, and his search for meaning beyond the equations.

Poetry excerpted from:
Чер, Г. (2017). Поэзия Древнего Египта. Ridero. ISBN 978-5-4490-1079-7.
Licensed under a Creative Commons Attribution-ShareAlike 4.0 International License.
The author, Gena Cher, is the pseudonym of Dr. Genady P. Cherepanov.

Poems in English:

*BLUE EYES**

Thy blue eyes
Softly look at me.
Elusive dreams rise
When I think of thee.

Thy blue eyes
Haunt me day and night.
Sea-blue dreams entice
My heart by their light.

**This song was selected to be an entry in the album "AMERICA", Hill Top Records, Beverly Hills, California (2009).*

CARRION CROW: A RUSSIAN TUNE
(a defiant emotion)

Carrion crow, carrion crow,
Why are you flying so low,
You aren't getting a prey,
Carrion crow, go away!
You aren't getting a prey, (chorus)
Carrion crow, go away!

Tell my dear cherished love
That I've found a truelove
That is now my real wife
Who's, forever, the only life!
That is now my real wife (chorus)
Who's, forever, the only life!

Bullets wed me to the battle,
I became a gun's chattel,
And the sword is my wife
To wage war to the knife!
And the sword is my wife (chorus)
To wage war to the knife!

Carrion crow, carrion crow,
Why are you flying so low,
You aren't getting a prey,
Carrion crow, go away!
You aren't getting a prey, (chorus)
Carrion crow, go away!

Inspired by the Russian folk song "Черный ворон," this defiant poem reflects Dr. Cherepanov's resilience.

PLEASE SAY GOODBYE
(To S. Yesenin)

No pity, no call, and no tears.
All goes by and all is getting dim,
Golden gray sits down on my years,
The youth behind and life's becoming grim.

My heart is now beating not the way
It did in the past hid by the mist of time,
And the birch grove and the stack of hay
Don't allure me to walk in or climb.

The spirit of adventure stirs my blood
Not quite the way it did that long ago.
Where is the freshness of the bud,
The passion, and the senses for to glow?

My wishes are fading day by day.
Oh, my life! Or, was it just a dream?
It seems I have galloped all my way
On the pink steed in a sunny stream.

We are to pass away in the long run,
Stars go out, please say goodbye...
I bless everything that has been done,
All that has come to live and die.

A philosophical farewell to youth and life, inspired by the Russian poet Sergei Yesenin.

A LONELY SAIL
(To M. Lermontov)

A lonely sail shows white
In the milky mist of blue sea.
What is he looking for in that far site?
What has he left in homeland heart-free?

The wind roars, the waves play,
The mast bends almost to fall
But he looks for no luck at bay
And flees a happy fate, at all.

The azure stream runs in a fancy form,
The golden beam of light is like a balm
But the rebellion seeks for a storm,
As if the storm keeps calm!

A free interpretation of Lermontov's famous poem, reflecting the restless spirit of the Romantic rebel.

IN THE WILD NORTH
(To J. Goethe)

In the wild North, on a mountain peak,
A lonely pine stands wind-swung;
He sleeps and snow beak
Covers him with white curtains hung.

He dreams around the clock:
In that land the sunrise wherefrom
Single and sad, on the hot rock,
Grows a beautiful palm.

A translation and reinterpretation of Goethe's famous poem, capturing the longing for a distant, warmer world.

A DATE IN THE GRAVE
(To H. Heine)

She yearned for him, he longed for her,
With the highest passion, we must concur;
But they evaded dating and declaration
And suffered in silent mutilation.

Then they departed to proudly crave
Each other's love, in dream and prayer.
Death came. They got a date in the grave...
But, one could not see the other there.

A haunting meditation on love, loss, and the cruel irony of fate, inspired by Heinrich Heine.

Стихи на русском:

ТЫ, ТИХИЙ ОКЕАН

Ты — Тихий океан, я — ручеёк,
Как мне понять тебя?
Я след оставил там, где тёк,
Не ведая того, что ты моя судьба.

Когда-то был я водопадом,
Крутая даль меня вела,
А моё счастье было рядом,
В омуте тихом, у села.

Но власти по-другому
Направили мой путь,
И к родному дому
Уж больше не свернуть.

Конец дороги близок,
Втеку я в океан,
А потом мой призрак
Смоет ураган.

О судьбе, о пути от малого к великому и о неизбежном слиянии с вечностью.

МЕЧТА

В сердце каждого созданья
Бьётся лёгкая мечта,
Для неё счастье — страданье,
Жизнь простая — тошнота.

От неё как птице в клетке
Никуда уйти нельзя,
Шаловлива та кокетка...
Но не смотрит мне в глаза.

Размышление о природе мечты — одновременно освобождающей и пленяющей.

ГРИБНОЙ ДОЖДЬ

Раз проснулся, слышу шорох,
Будто дождик на просторах,
Пальмы выстроились в ряд
И тихонько говорят:

"Друг наш ситный, оглянись-ка,
Вспомни жизни ураган,
Сколько было шума, риска,
И в кого стрелял наган.

Что ты ищешь в минном поле,
Накликать хочешь беду?
Мало ценишь свою долю,
Разум потерял в бреду?

Хочешь горные вершины
Взглядом снизу покорить,
Не боишься, что лавина
Может с головой накрыть?

Что с тобою, парень шалый?
Хоть по сердцу буря, град,
Где ты бед нажил немало,
Будь дождю грибному рад!

Уж не будет тебе счастья,
Позабудь о том навек,

Ничего кроме ненастья
Не несёт сверхчеловек.

В бурых пятнах гимнастёрка,
Что в крови твоего отца,
Той великой жизни тёрка
Бередит людей сердца."

Разговор с самим собой о жизни, риске, судьбе и памяти отца.

ЭДЕЛЬВЕЙС

Помню то утро,
Альпийский гнейс,
Будто из перламутра
Цветок эдельвейс.

Холод жестокий
В седой вышине,
Он — одинокий
В глухой тишине.

Судьбы злой рок
У него на роду,
Но грезит цветок
Про розу в саду!

Символ стойкости и одиночества — цветок в горах, мечтающий о садовой розе.

Discussion Topics — Dr. Genady P. Cherepanov's Scientific Legacy

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Introduction

Welcome to the Discussion section of the Dr. Genady P. Cherepanov Memorial Website. This page is designed to foster thoughtful, scholarly, and philosophical dialogue about the scientific legacy of Dr. Cherepanov and the broader questions his work raises about the nature of science, discovery, and the pursuit of truth.

The topics presented below are intended for **educational, philosophical, and archival purposes**. They are not intended to provoke conflict or controversy, but rather to invite reflection, curiosity, and respectful exchange of ideas. Dr. Cherepanov himself was a scientist who valued intellectual independence and the courage to question established authority. This page honors that spirit.

A. Discussion Topics

Topic 1 — Dr. Cherepanov's NEOC Model vs. Cosmology Based on Einstein's GR Principle

Background:

Dr. Cherepanov's NEOC (Neoclassic Cosmology) model offers an alternative to the standard ΛCDM cosmology, which is based on Einstein's General Relativity (GR). Instead of relying on curved spacetime, the NEOC model is built on the **invariant integral** — a path-independent energy conservation law. The model assumes a flat, Euclidean universe and includes a repulsive term proportional to distance, which Cherepanov interpreted as the centrifugal force of a slowly rotating universe.

Key Questions for Discussion:

- What are the philosophical implications of replacing curved spacetime with a flat Euclidean universe?
- Can a single mathematical principle — the invariant integral — truly unify mechanics, electrodynamics, and cosmology?

- Why has the NEOC model not been widely adopted by mainstream cosmologists? Is it due to scientific, political, or institutional reasons?
- What would it take for an alternative cosmological model to be taken seriously by the scientific establishment?
- Is there a place for "outsider" theories in modern cosmology, or has the field become too specialized and insular?

Suggested Reading:

- Cherepanov, G.P. (2019). *Invariant Integrals in Physics*. Springer. Chapter 11: Cosmology.
- Cherepanov, G.P. (2015). "The invariant integral: some news." *Physical Mesomechanics*, Vol. 18, No. 3, pp. 203-212.

Topic 2 — Fiction or Realistic Future? The Future of Underground Moving Vehicles Based on Deep Penetration Mechanics

Background:

Dr. Cherepanov made significant contributions to the mechanics of super-deep penetration, particularly the discovery of the **super-penetration effect** of thin wing-shaped penetrators moving at the Rayleigh speed. His work, supported by NASA grants, identified a new regime of high-speed penetration with potential applications in space debris shielding, armor design, and — perhaps more speculatively — underground transportation.

The Concept:

Imagine a future where vehicles move through solid rock not by tunneling, but by creating a self-sustaining fracture wave that allows the vehicle to "swim" through the Earth's crust. Based on Cherepanov's fracture wave theory, such a vehicle could potentially travel at extraordinary speeds, reshaping the way we think about transportation, resource extraction, and even planetary exploration.

Key Questions for Discussion:

- Is deep penetration technology feasible for transportation, or is it limited to military and space applications?
- What are the engineering challenges of creating a vehicle that can move through solid rock?

- Could fracture wave mechanics be harnessed for sustainable energy extraction or planetary exploration?
- How close is current technology to realizing the vision of underground high-speed travel?
- What ethical and environmental considerations would accompany such a technology?

Suggested Reading:

- Cherepanov, G.P. (1994). "Super-deep penetration." *Engineering Fracture Mechanics*, Vol. 47, No. 5, pp. 691-713.
- Cherepanov, G.P. (1994). "Zero drag of a thin wing moving in an elastic medium at the Rayleigh speed." *Journal of Applied Mechanics*, Vol. 61, No. 4, pp. 988-991.

Topic 3 — The Philosophy of Scientific Principles: Should a New Principle That Derives Existing Laws Be Considered More Fundamental?

Background:

Dr. Cherepanov's invariant integral approach allowed him to re-derive several classical laws — Archimedes' buoyancy principle, Newton's laws of motion, Coulomb's law, and even Einstein's $E=mc^2$ — as **particular cases** of a more general conservation principle. This raises a profound philosophical and scientific question: If a new principle can derive existing laws as special cases, should it be considered more fundamental than those laws?

Key Questions for Discussion:

- Does the ability to derive established laws make a new principle "more fundamental"?
- What criteria should we use to judge the fundamentality of a scientific principle — explanatory power, predictive power, mathematical elegance, or experimental verification?
- Is it possible that the invariant integral is a more fundamental description of physical reality than Newtonian mechanics?
- How should scientists respond to a new principle that challenges established theories?

- What is the role of mathematics in discovering fundamental physical laws?

Suggested Reading:

- Cherepanov, G.P. (2019). *Invariant Integrals in Physics*. Springer. (Throughout)
- Cherepanov, G.P. (1967). "Crack propagation in continuous media." *PMM*, Vol. 31, No. 3, pp. 476-488.

Topic 4 — How Close Are Dr. Cherepanov's Findings to a Unified Theory of Physics?

Background:

Dr. Cherepanov's work on invariant integrals sought to demonstrate the unity of conservation principles across multiple fields — mechanics, electrodynamics, gravity, and cosmology. His generalized Coulomb law for relativistic charges (the CBC law) and his NEOC cosmological model are examples of attempts to unify disparate areas of physics. The question of unification — whether all physical phenomena can be described by a single, elegant mathematical framework — has been a holy grail of physics since Einstein.

Key Questions for Discussion:

- How close did Dr. Cherepanov come to a unified theory of physics?
- Is unification even possible, or are there fundamental limits to our ability to describe reality with a single set of principles?
- What role do invariant integrals play in the search for unification?
- Could the invariant integral be the missing link between quantum mechanics and general relativity?
- Is the pursuit of unification a worthwhile scientific goal, or does it distract from more practical research?

Suggested Reading:

- Cherepanov, G.P. (2019). *Invariant Integrals in Physics*. Springer.
- Cherepanov, G.P. (1994). "Generalized Coulomb's law (the CBC law)" (with Borzykh). *Journal of Applied Physics*.

Topic 5 — A True Renaissance Man? Dr. Cherepanov's 17 Major Fields and 91 Subfields

Background:

Dr. Cherepanov contributed to at least **17 major scientific fields** and **91 distinct subfields** — ranging from pure mathematics and fracture mechanics to geophysics, cosmology, political science, and mathematical sociology. This extraordinary breadth raises the question: Is there anyone else like him in the history of science?

Key Questions for Discussion:

- Are there other scientists in history who have contributed to such a wide range of fields?
- Is breadth of knowledge still possible in an age of increasing scientific specialization?
- Does a "Renaissance scientist" like Cherepanov have a role in modern science, or has specialization made such versatility obsolete?
- What conditions (intellectual, cultural, institutional) allow a scientist to work across so many fields?
- Does the scientific community value breadth as much as depth?

Suggested Reading:

- Biography of Dr. Genady P. Cherepanov (this website)
- Scientific Contributions of Dr. Genady P. Cherepanov (this website)

Topic 6 — Analysis of the Current State of Fundamental Science: Is There a Crisis?

Background:

Many commentators have noted a slowdown in fundamental scientific discoveries over the past 50 years. Some argue that science has become too specialized, too bureaucratic, or too focused on incremental advances rather than paradigm-shifting breakthroughs. Others point to institutional corruption, the prioritization of funding over truth, and the suppression of unconventional ideas.

Dr. Cherepanov's struggles for recognition — his priority disputes, his controversial positions, and his eventual marginalization — may be symptomatic of a broader malaise in science.

Key Questions for Discussion:

- Is fundamental science in a state of crisis, or are we simply in a period of consolidation?
- What role does institutional politics play in the recognition (or non-recognition) of scientific discoveries?
- Are modern scientists too focused on securing funding and positions, rather than pursuing truth?
- Was Dr. Cherepanov a "Last of the Mohicans" — a representative of a dying breed of independent, courageous scientists?
- Is the silence on Dr. Cherepanov's contributions a deliberate conspiracy, an accident of history, or a reflection of the "survival of the fittest" in science?

Suggested Reading:

- Cherepanov, G.P. (2009). "Scientific Battles: Moscow, 1960s." *Vestnik Samarskogo Gosudarstvennogo Universiteta*, No. 2(68).
- Various biographies and memoirs on this website.

B. How to Engage in Discussion

We invite you to carry forward these discussion topics on various platforms. Here are some suggestions for how you can participate:

Suggested Platforms

Platform	Best For
Twitter/X	Short, focused commentary; sharing links; engaging with others
Facebook	Longer discussions; sharing with friends and groups
Reddit	In-depth, anonymous discussions; finding like-minded communities

Platform	Best For
LinkedIn	Professional and scholarly discourse; sharing with colleagues
Personal Blogs	Extended essays and reflections
YouTube	Video essays and presentations
Academic Forums	Scholarly debate and peer discussion

Suggested Hashtags

When posting on social media, please consider using these hashtags to help others find the discussion:

- `#Cherepanov`
- `#GenadyCherepanov`
- `#FractureMechanics`
- `#InvariantIntegral`
- `#NEOC`
- `#Nanofracture`
- `#ScientificLegacy`
- `#Cosmology`
- `#Physics`
- `#HistoryOfScience`
- `#ScienceDiscussion`

Suggested Post Templates

Twitter/X (short):

"Just read about Dr. Genady Cherepanov's NEOC cosmology — an alternative to Einstein's GR based on the invariant integral. What do you think? Is there room for alternative cosmologies in modern physics? #Cherepanov #NEOC #Cosmology #ScienceDiscussion"

LinkedIn (professional):

"I recently came across the work of Dr. Genady P. Cherepanov — a scientist who contributed to 17 major fields and 91 subfields. His work on invariant integrals, nanofracture mechanics, and NEOC cosmology raises important questions about the nature of scientific discovery and recognition. I invite you to explore his legacy at www.genadycherepanov.com and join the discussion: Should a new principle that derives existing laws be considered more fundamental? #Cherepanov #ScientificLegacy #Physics #Engineering #MaterialsScience"

Reddit (longer):

"Hi everyone, I've been exploring the work of Dr. Genady P. Cherepanov, a scientist who contributed to 17 major fields and 91 subfields — including fracture mechanics, cosmology, and mathematical sociology. His invariant integral approach derives Newton's laws, Coulomb's law, and even Einstein's $E=mc^2$ as special cases. I'm curious to hear from the community: What do you think about the status of such 'outsider' contributions in modern science? Why do you think his work hasn't received more recognition? Check out his memorial website for more: www.genadycherepanov.com"

How to Use the Materials on This Website

Resource	How to Use
Biography	Provides context for understanding his life and struggles
Scientific Contributions	Offers detailed explanations of his discoveries
Publications	Lists his books and papers for citation
Memoriam	Reflects on his legacy and character
WTC Analysis	Explores his unconventional work
NEOC Cosmology	Presents his alternative cosmological model
Archives	Contains photos, documents, and poetry

C. Rules of Engagement, Terms, and Disclaimer

Terms of Use

By participating in discussions about Dr. Cherepanov's work, you agree to the following terms:

1. **Respectful Discourse** — All discussions should be conducted with respect for other participants, even when disagreements arise.
2. **Scientific Focus** — Discussions should focus on the scientific content of Dr. Cherepanov's work, not on personal attacks or ad hominem arguments.
3. **Evidence-Based** — Participants are encouraged to support their arguments with evidence, citations, and reasoned logic.
4. **No Harassment** — Harassment, bullying, or intimidation of any kind will not be tolerated.
5. **Constructive Criticism** — Critiques of Dr. Cherepanov's work are welcome, but they should be constructive and grounded in scientific reasoning.

Disclaimer

The views expressed in Dr. Cherepanov's works are his own and do not necessarily reflect the views of this website's maintainers. The topics presented on this page are intended for **educational, critical, and archival purposes**. Readers are encouraged to consult the full range of scientific literature on the subjects discussed.

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